Manitoba and Climate Change: A Primer

The Climate is Changing

Impacts on Manitoba, Canada and the World

Opportunities and Challenges for Manitobans

What You Can Do

What's Ahead

Internet Resources

IISD

INTERNATIONAL INSTITUTE FOR SUSTAINABLE DEVELOPMENT

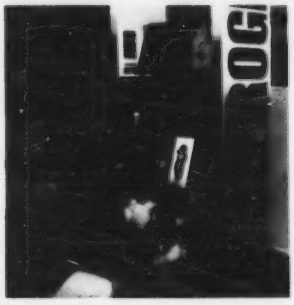
INSTITUT INTERNATIONAL DU DÉVELOPPEMENT DURABLE

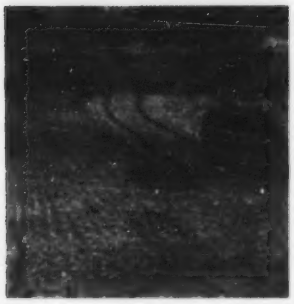
Manitoba Clean Environment Commission

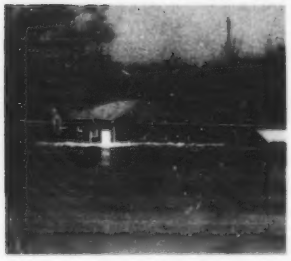
Manitoba and Climate Change: A Primer

Table of Contents

The Climate is Changing	3
The Science and Impacts of Climate Change	4
The International and Canadian Responses to Climate Change	11
The Implications of Climate Change for Manitoba: Opportunities and Challenges	19
The Path Ahead	28







Cover Photo: Flood of the Century, Red River Valley, May 1997.
Photo by Peggy Tyrchniewicz

Layout and Design – Don Berg

Photos top to bottom:
Photo courtesy Kraus Group Inc.
Photo courtesy Manitoba Agriculture
Photo courtesy Manitoba Hydro
Photo by Elaine Gauer, Manitoba Agriculture

The **Manitoba Clean Environment Commission** (CEC) was established to facilitate public participation in the management of the province's natural environment. The Commission accomplishes this through a variety of mechanisms including the public hearing process, through which advice is provided to government on specific environmental licensing matters, and by offering mediation services through which environmental disputes can be addressed. In addition, the Commission's mandate includes an obligation to encourage public education initiatives that raise awareness and understanding of environmental issues.

The **International Institute for Sustainable Development** (IISD) is an independent, not-for-profit corporation headquartered in Winnipeg, Canada, established by the governments of Canada and Manitoba. IISD receives financial support from the governments of Canada and Manitoba, other governments, UN agencies, foundations and the private sector. IISD's vision is better living for all—sustainably; its mission is to champion innovation, enabling societies to live sustainably.

© The Manitoba Clean Environment Commission and the International Institute for Sustainable Development 2001.

Published by International Institute for Sustainable Development and the Manitoba Clean Environment Commission.

All rights reserved

Printed in Canada

Copies are available from

The Manitoba Clean Environment Commission
305-155 Carlton St.
Winnipeg, MB R3C 3H8

Canadian Cataloguing in Publication Data

Main entry under title:

Manitoba and climate change: A primer

Includes bibliographical references.

ISBN 1-895536-31-6

1. Climate changes—Manitoba. 2. Climate changes—Environmental aspects—Manitoba. I. International Institute for Sustainable Development.

QC985.5.M35C54 2001 551.697127 C00-911596-X

This publication is printed on recycled paper.

International Institute for Sustainable Development
161 Portage Avenue East, 6th Floor
Winnipeg, Manitoba, Canada
R3B 0Y4

Telephone: (204) 958-7700
Fax: (204) 958-7710
E-mail: info@iisd.ca
Internet: http://www.iisd.org

M121

IMPORTANT NOTE CONCERNING THE FOLLOWING PAGES

THE PAGES WHICH FOLLOW HAVE BEEN FILMED TWICE IN ORDER TO OBTAIN THE BEST REPRODUCTIVE QUALITY

USERS SHOULD CONSULT ALL THE PAGES REPRODUCED ON THE FICHE IN ORDER TO OBTAIN A COMPLETE READING OF THE TEXT.

REMARQUE IMPORTANTE CONCERNANT LES PAGES QUI SUIVENT

LES PAGES SUIVANTES ONT ÉTÉ REPRODUITES EN DOUBLE AFIN D'AMÉLIORER LA QUALITÉ DE REPRODUCTION

LES UTILISATEURS DOIVENT CONSULTER TOUTES LES PAGES REPRODUITES SUR LA FICHE AFIN D'OBTENIR LA LECTURE DU TEXTE INTÉGRAL

micromedia
a division of IHS Canada

20 Victoria Street
Toronto, Ontario M5C 2N8
Tel.: (416) 362-5211
Toll Free: 1-800-387-2689
Fax: (416) 362-6161
Email: info@micromedia.on.ca

101-04889/

The Climate is Changing

By the end of this century, Manitoba will be 4–6 degrees C warmer, on average, than it is today. Sounds great? It isn't. Manitoba is particularly sensitive and vulnerable to climate change because of the important role that renewable resources—like forests and agriculture—play in our economy. Change of this magnitude would impact our economy, ecology, and health and well-being.

Climate change is the most significant global environmental threat facing Manitobans. Understanding its impacts and developing a thoughtful response to this very real challenge is critical if we want to ensure an acceptable quality of life for future generations of Manitobans. Climate change represents the concrete manifestation of sustainable development in many ways—an effective response calls for policy and action across the full range of human economic and development activities.

Taking action now to begin managing and adapting to the threat of climate change will work to minimize costs for future generations. It is more effective and less expensive to adapt to climate change over time rather than being forced to adopt more extreme, emergency adaptation techniques in the future when the best solutions are not necessarily available. And the challenge is also an opportunity. By being proactive, Manitobans can develop new markets and become leaders in the development and distribution of climate-friendly technologies.

So, what exactly is climate change? The term, often used interchangeably with global warming, refers to the overall warming of the earth's atmosphere caused by human-generated emissions of greenhouse gases, mostly carbon dioxide, nitrous oxide and methane. The two most critical variables in global warming are the expected range and rate of temperature change. For example, the latest estimates predict a global average temperature rise of 1.4 to 5.8 degrees Celsius between 1990 and 2100. Manitoba is expected to experience warming at the higher end of that range. Recent conclusions of the Intergovernmental Panel on Climate Change (IPCC) confirm what many have suspected—that the range and rate of climate change expected over the next century is greater than what was previously predicted, with consequent greater impacts on our ecology, economy and society.

And why should we worry about climate change? It is difficult to predict what the specific regional impacts will be. It is certain, however, that the overall impacts will be harmful. This will be particularly true for those regions of the world that are the least responsible for producing greenhouse gases, yet the most directly affected—the small island states and impoverished areas of the developing world, for example. While Manitobans, if adequately prepared, might be able to adapt to climate change, we must not lose sight of our moral responsibility to those areas of the globe that would likely be devastated. This calls for the support of strong, sensible action to mitigate our greenhouse gas emissions and help for more vulnerable regions to develop appropriate policies in response to climate change.

This primer is intended to be the first place Manitobans need look for an overview of the science and impacts of climate change, the international and Canadian responses, and the challenges and opportunities that Manitobans face in mitigating and adapting to climate change.

101-04889/

The Climate is Changing

By the end of this century, Manitoba will be 4–6 degrees C warmer, on average, than it is today. Sounds great? It isn't. Manitoba is particularly sensitive and vulnerable to climate change because of the important role that renewable resources—like forests and agriculture—play in our economy. Change of this magnitude would impact our economy, ecology, and health and well-being.

Climate change is the most significant global environmental threat facing Manitobans. Understanding its impacts and developing a thoughtful response to this very real challenge is critical if we want to ensure an acceptable quality of life for future generations of Manitobans. Climate change represents the concrete manifestation of sustainable development in many ways—an effective response calls for policy and action across the full range of human economic and development activities.

Taking action now to begin managing and adapting to the threat of climate change will work to minimize costs for future generations. It is more effective and less expensive to adapt to climate change over time rather than being forced to adopt more extreme, emergency adaptation techniques in the future when the best solutions are not necessarily available. And the challenge is also an opportunity. By being proactive, Manitobans can develop new markets and become leaders in the development and distribution of climate-friendly technologies.

So, what exactly is climate change? The term, often used interchangeably with global warming, refers to the overall warming of the earth's atmosphere caused by human-generated emissions of greenhouse gases, mostly carbon dioxide, nitrous oxide and methane. The two most critical variables in global warming are the expected range and rate of temperature change. For example, the latest estimates predict a global average temperature rise of 1.4 to 5.8 degrees Celsius between 1990 and 2100. Manitoba is expected to experience warming at the higher end of that range. Recent conclusions of the Intergovernmental Panel on Climate Change (IPCC) confirm what many have suspected—that the range and rate of climate change expected over the next century is greater than what was previously predicted, with consequent greater impacts on our ecology, economy and society.

And why should we worry about climate change? It is difficult to predict what the specific regional impacts will be. It is certain, however, that the overall impacts will be harmful. This will be particularly true for those regions of the world that are the least responsible for producing greenhouse gases, yet the most directly affected—the small island states and impoverished areas of the developing world, for example. While Manitobans, if adequately prepared, might be able to adapt to climate change, we must not lose sight of our moral responsibility to those areas of the globe that would likely be devastated. This calls for the support of strong, sensible action to mitigate our greenhouse gas emissions and help for more vulnerable regions to develop appropriate policies in response to climate change.

This primer is intended to be the first place Manitobans need look for an overview of the science and impacts of climate change, the international and Canadian responses, and the challenges and opportunities that Manitobans face in mitigating and adapting to climate change.

The Science and Impacts of Climate Change

The History of Climate on the Canadian Prairies

Climate change isn't new. It's as old as the atmosphere itself. Studies have documented the nature, magnitude and impact of historical climate change. What's expected to happen on the prairies in the next century, has in fact happened in the more distant past, allowing researchers to identify natural systems most sensitive to current and impending climate change. For instance, a drought that started in the 1790s was severe enough to initiate extensive sand dune activity across the southern prairies, something that did not occur as a result of the droughts in the 1930s or 1980s. Historical studies have suggested that levels and quality of water bodies, which are especially vulnerable to climate change, have fluctuated in response to even short-term periods of warm, dry weather or very wet weather. During the warmest interval of the last 10,000 years—5,000 to 7,000 years ago—water tables across the prairies were 4–10 m below current levels.[1]

At that time, the prairies were considerably warmer and drier than they are today. Lake sediment records from northern Alberta and west-central Manitoba indicate that summer temperatures were about two degrees C higher, compared to the projected 4–6 degree C increase by the end of this century. Growing season precipitation was about 15 per cent lower than it is today. With the exception of a few deeper lakes, groundwater-fed lakes on the southern prairies were completely dry. While the increased warming was primarily a result of greater solar radiation, this period is of particular interest as the magnitude of temperature change expected to occur by 2050 is roughly comparable to the climate of that time.

The Prairie Provinces had two distinct climate events during the last millennium.[2] The most recent of these, the "Little Ice Age," occurred between 1450 and 1850. It was the coldest period in the Northern Hemisphere in the last 10,000 years. And despite a generally cooler climate, tree rings demonstrate that the most severe drought of the past 500 years occurred during this period, from about 1790 to 1800.

The second major climate event on the prairies was the "Medieval Warm Period," from approximately 900 to 1200 AD. This was a period of severe drought on the southern prairies, far exceeding the frequency and magnitude of droughts experienced in the last 100 years. The magnitude of climatic changes associated with these events was particularly pronounced in the southern half of the prairies.

1 Herrington, R. *et al.*, *Prairie Adaptation: Backgrounder*, Prairie Adaptation Research Co-operative, March 1999.

2 *ibid.*

Today's Climate in Manitoba

Manitoba's climate is determined by our location in the middle of North America. It includes cold temperate as well as sub-Arctic climatic regions, ranging from dry continental-type conditions in the southwest, to near Arctic conditions in the northeast along Hudson Bay. The Rocky Mountains prevent the moisture-bearing winds of the Pacific from reaching the area, resulting in a continental climate, with sub-humid to semi-arid conditions with short, hot summers; long, cold winters; low levels of precipitation; and high evaporation. Throughout the year, moist and warmer air from the U.S. Midwest affects southern Manitoba and sometimes leads to large regional rain and snow events. During the winter, frigid Arctic air flows southward across Manitoba, frequently producing blowing snow and high wind chill conditions. While Manitobans enjoy mainly sunny skies throughout the year, considerable cloudiness in the fall and spring occurs due to the variation in storm patterns across the region.

The extreme northeast of Manitoba is affected by its proximity to Hudson Bay. During the summer months, Churchill and other coastal communities frequently experience sea breezes off the cold water and/or ice-covered Hudson Bay. Elsewhere, large lakes can have strong local effects, including increased cloudiness; a longer but cooler growing season; lake-induced snow squalls in the fall; and complex local winds.

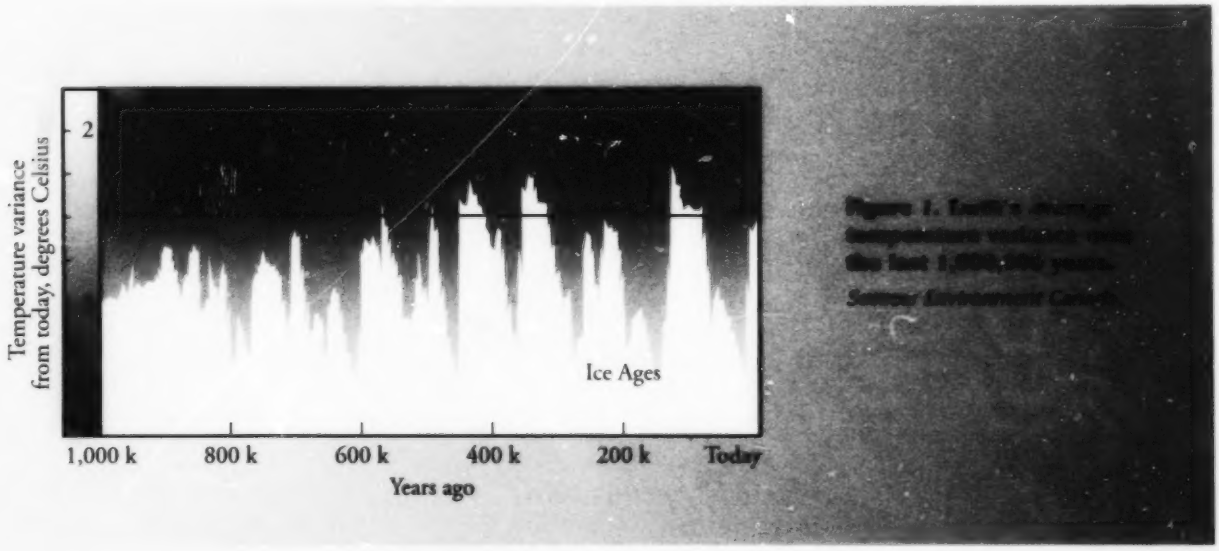
Mean winter temperatures range from –12.5 to –8 degrees C and mean summer temperatures from 14 to 16 degrees C. Mean annual precipitation has extreme variability, ranging from 300 mm in the west to almost 700 mm in the east.

The Impacts of Climate Change for Manitoba

Thanks to its location in the middle of a continent at relatively high latitudes, Manitoba is likely to face earlier and more severe climate change than many parts of the world. Climate models agree that all regions in Canada, including Manitoba, will experience higher temperatures by the middle of this century.

The Canadian model, produced by the Canadian Centre for Climate Modelling and Analysis, predicts above-normal spring temperature increases across Canada, most significantly affecting the prairies and the north. This increase is predicted to lead to earlier seeding times for most crops. Springtime precipitation across Canada is expected to rise, with an increase on the prairies ranging from five to 20 per cent. This could work to increase groundwater recharge and soil moisture. With higher temperatures and more precipitation in the spring, some areas of the prairies could experience more flooding.

According to the model, summer temperatures will increase by three to four degrees C. This has the potential to increase evaporation across the country, reducing the amount of available water and perhaps causing crises in water management in all parts of Canada. With much higher evaporation and temperatures and little change in precipitation, increased drought conditions are projected. In all regions in Canada, the higher temperatures should lengthen the growing season by increasing the



The Science and Impacts of Climate Change

The History of Climate on the Canadian Prairies

Climate change isn't new. It's as old as the atmosphere itself. Studies have documented the nature, magnitude and impact of historical climate change. What's expected to happen on the prairies in the next century, has in fact happened in the more distant past, allowing researchers to identify natural systems most sensitive to current and impending climate change. For instance, a drought that started in the 1790s was severe enough to initiate extensive sand dune activity across the southern prairies, something that did not occur as a result of the droughts in the 1930s or 1980s. Historical studies have suggested that levels and quality of water bodies, which are especially vulnerable to climate change, have fluctuated in response to even short-term periods of warm, dry weather or very wet weather. During the warmest interval of the last 10,000 years—5,000 to 7,000 years ago—water tables across the prairies were 4–10 m below current levels.[1]

At that time, the prairies were considerably warmer and drier than they are today. Lake sediment records from northern Alberta and west-central Manitoba indicate that summer temperatures were about two degrees C higher, compared to the projected 4–6 degree C increase by the end of this century. Growing season precipitation was about 15 per cent lower than it is today. With the exception of a few deeper lakes, groundwater-fed lakes on the southern prairies were completely dry. While the increased warming was primarily a result of greater solar radiation, this period is of particular interest as the magnitude of temperature change expected to occur by 2050 is roughly comparable to the climate of that time.

The Prairie Provinces had two distinct climate events during the last millennium.[2] The most recent of these, the "Little Ice Age," occurred between 1450 and 1850. It was the coldest period in the Northern Hemisphere in the last 10,000 years. And despite a generally cooler climate, tree rings demonstrate that the most severe drought of the past 500 years occurred during this period, from about 1790 to 1800.

The second major climate event on the prairies was the "Medieval Warm Period," from approximately 900 to 1200 AD. This was a period of severe drought on the southern prairies, far exceeding the frequency and magnitude of droughts experienced in the last 100 years. The magnitude of climatic changes associated with these events was particularly pronounced in the southern half of the prairies.

1 Herrington, R. *et al.*, *Prairie Adaptation: Backgrounder*, Prairie Adaptation Research Co-operative, March 1999.

2 *ibid.*

Today's Climate in Manitoba

Manitoba's climate is determined by our location in the middle of North America. It includes cold temperate as well as sub-Arctic climatic regions, ranging from dry continental-type conditions in the southwest, to near Arctic conditions in the northeast along Hudson Bay. The Rocky Mountains prevent the moisture-bearing winds of the Pacific from reaching the area, resulting in a continental climate, with sub-humid to semi-arid conditions with short, hot summers; long, cold winters; low levels of precipitation; and high evaporation. Throughout the year, moist and warmer air from the U.S. Midwest affects southern Manitoba and sometimes leads to large regional rain and snow events. During the winter, frigid Arctic air flows southward across Manitoba, frequently producing blowing snow and high wind chill conditions. While Manitobans enjoy mainly sunny skies throughout the year, considerable cloudiness in the fall and spring occurs due to the variation in storm patterns across the region.

The extreme northeast of Manitoba is affected by its proximity to Hudson Bay. During the summer months, Churchill and other coastal communities frequently experience sea breezes off the cold water and/or ice-covered Hudson Bay. Elsewhere, large lakes can have strong local effects, including increased cloudiness; a longer but cooler growing season; lake-induced snow squalls in the fall; and complex local winds.

Mean winter temperatures range from –12.5 to –8 degrees C and mean summer temperatures from 14 to 16 degrees C. Mean annual precipitation has extreme variability, ranging from 300 mm in the west to almost 700 mm in the east.

The Impacts of Climate Change for Manitoba

Thanks to its location in the middle of a continent at relatively high latitudes, Manitoba is likely to face earlier and more severe climate change than many parts of the world. Climate models agree that all regions in Canada, including Manitoba, will experience higher temperatures by the middle of this century.

The Canadian model, produced by the Canadian Centre for Climate Modelling and Analysis, predicts above-normal spring temperature increases across Canada, most significantly affecting the prairies and the north. This increase is predicted to lead to earlier seeding times for most crops. Springtime precipitation across Canada is expected to rise, with an increase on the prairies ranging from five to 20 per cent. This could work to increase groundwater recharge and soil moisture. With higher temperatures and more precipitation in the spring, some areas of the prairies could experience more flooding.

According to the model, summer temperatures will increase by three to four degrees C. This has the potential to increase evaporation across the country, reducing the amount of available water and perhaps causing crises in water management in all parts of Canada. With much higher evaporation and temperatures and little change in precipitation, increased drought conditions are projected. In all regions in Canada, the higher temperatures should lengthen the growing season by increasing the

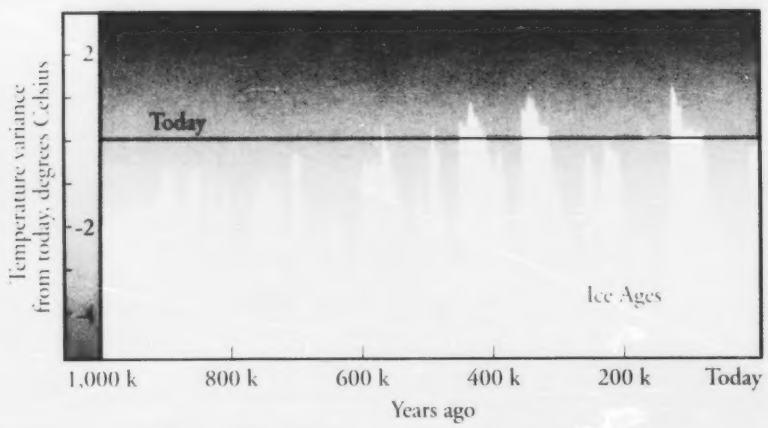


Figure 1. Earth's average temperature variance over the last 1,000,000 years.
Source: Environment Canada

What Are Greenhouse Gases?

Much like what occurs in greenhouses where heat is held inside, greenhouse gases are those in the atmosphere that act like a blanket to keep the earth warm. This is known as the greenhouse effect, a natural phenomenon vital to life on earth. The sun irradiates the earth and about 70 per cent of the incoming radiation is absorbed by gases in the atmosphere and by the planet's surface. The average temperature of the earth's atmosphere is raised by the energy trapped by these gases, maintaining the planet's temperature within a habitable range. The natural greenhouse effect causes the earth's surface to be about 33 degrees C higher than it would be without. However, increasing levels of GHG emissions as a result of human activities in, for example, transportation, energy, agriculture and forestry, are leading to rapidly increasing GHG concentrations which would destabilize our global climate. Current concentrations in the atmosphere have risen rapidly since the mid- 1800s and are now at the highest values in over 400,000 years.

Carbon dioxide is the most common greenhouse gas released by human activities. CO_2 is produced from decaying materials, respiration of plant and animal life, and combustion of organic materials and fossil fuels such as natural gas, oil and coal. Once emitted, carbon remains in the climate system for a century or more.

Another significant GHG produced as result a of human activity is methane, which is produced when matter decays in the absence of oxygen. Primary sources of methane include land management, wetlands, animal waste and digestive processes, fossil fuel extraction, and decaying garbage in landfills.

To effectively compare the impacts of greenhouse gases in the atmosphere, their lifespans have been converted into global warming potential over 100 years. Compared with carbon dioxide, methane is 21 times more potent per molecule as a greenhouse gas, but it is much less abundant and has a shorter residence time of about 12 years. Humans contribute to emissions of nitrous oxide through soil cultivation, the production and use of nitrogen fertilizers, production of nylon, and the burning of organic material and fossil fuels. This gas is roughly 310 times per molecule more capable of trapping heat than carbon dioxide with a lifetime of 120 years in the atmosphere. Other GHGs produced as the result of human activity include fluorocarbons (CFCs, HCFCs and PFCs) and sulfur hexafloride (SF_6). While their concentration is very small (less than one per cent), they have considerably higher heat-trapping potential, with some as high as 10,000 times per molecule more powerful than CO_2 with some exceeding a millennium in residence time.

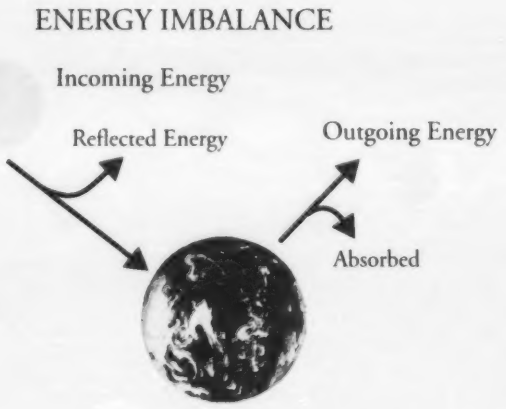


Figure 2. Greenhouse gas effect on the earth.

Source: Environment Canada

Table 1. Greenhouse gases covered by the Kyoto Protocol.

Source: A Guide to Kyoto: Climate Change and What It Means to Canadians. IISD, 1998.

Substance	Chemical symbol	Sources/Use	Damage to atmosphere	Lifespan
Carbon dioxide	CO_2	- occurs naturally - combustion of fossil fuels (coal, natural gas, petroleum) - deforestation (CO_2 released when trees decay or burn)	- United Nations estimates that CO_2 is currently responsible for over 60 per cent of the "enhanced" greenhouse effect, which is responsible for climate change	- calculations are imprecise because billions of tonnes of CO_2 are exchanged naturally each year - CO_2 levels varied by less than 10 per cent before industrialization - in the 200 years since 1800, levels have risen by almost 30 per cent
Nitrous oxide	N_2O	- occurs naturally - fertilizers - high temperature combustion of fossil fuels	- a molecule of N_2O is 200-300 times more effective than a molecule of CO_2 in greenhouse warming	- 150 years
Methane	CH_4	- occurs naturally - flooded rice paddies - farm animals - waste dumps - coal mining and natural gas production	- currently contributes 15–20 per cent of the enhanced greenhouse effect	- 11 to 12 years
Halocarbons - chlorofluorocarbons (CFCs) - hydrochlorofluoro-carbons (HCFCs)	- multiple (there are many types)	- used to make foam, cleaners, aerosol sprays, and coolants for refrigeration and air conditioning equipment	- destroys ozone layer - contributes to the enhanced greenhouse effect	- up to 400 years
Perfluorocarbons (PFCs)	- multiple (there are many types)	- used in solvents (particularly for cleaning electronic equipment) and fire suppression equipment	- global warming potential is 5,000–10,000 times greater than CO_2	- 3,000–5,000 years
Sulphur hexafluoride	SF_6	- an insulating alternative to mineral oil or air in some high-voltage equipment as well as for water leak detection in cable cooling systems	- has a much greater greenhouse potential than CO_2, but concentrations in atmosphere are very low	- ongoing research

What Are Greenhouse Gases?

Much like what occurs in greenhouses where heat is held inside, greenhouse gases are those in the atmosphere that act like a blanket to keep the earth warm. This is known as the greenhouse effect, a natural phenomenon vital to life on earth. The sun irradiates the earth and about 70 per cent of the incoming radiation is absorbed by gases in the atmosphere and by the planet's surface. The average temperature of the earth's atmosphere is raised by the energy trapped by these gases, maintaining the planet's temperature within a habitable range. The natural greenhouse effect causes the earth's surface to be about 33 degrees C higher than it would be without. However, increasing levels of GHG emissions as a result of human activities in, for example, transportation, energy, agriculture and forestry, are leading to rapidly increasing GHG concentrations which would destabilize our global climate. Current concentrations in the atmosphere have risen rapidly since the mid- 1800s and are now at the highest values in over 400,000 years.

Carbon dioxide is the most common greenhouse gas released by human activities. CO_2 is produced from decaying materials, respiration of plant and animal life, and combustion of organic materials and fossil fuels such as natural gas, oil and coal. Once emitted, carbon remains in the climate system for a century or more.

Another significant GHG produced as result a of human activity is methane, which is produced when matter decays in the absence of oxygen. Primary sources of methane include land management, wetlands, animal waste and digestive processes, fossil fuel extraction, and decaying garbage in landfills.

To effectively compare the impacts of greenhouse gases in the atmosphere, their lifespans have been converted into global warming potential over 100 years. Compared with carbon dioxide, methane is 21 times more potent per molecule as a greenhouse gas, but it is much less abundant and has a shorter residence time of about 12 years. Humans contribute to emissions of nitrous oxide through soil cultivation, the production and use of nitrogen fertilizers, production of nylon, and the burning of organic material and fossil fuels. This gas is roughly 310 times per molecule more capable of trapping heat than carbon dioxide with a lifetime of 120 years in the atmosphere. Other GHGs produced as the result of human activity include fluorocarbons (CFCs, HCFCs and PFCs) and sulfur hexafloride (SF_6). While their concentration is very small (less than one per cent), they have considerably higher heat-trapping potential, with some as high as 10,000 times per molecule more powerful than CO_2 with some exceeding a millennium in residence time.

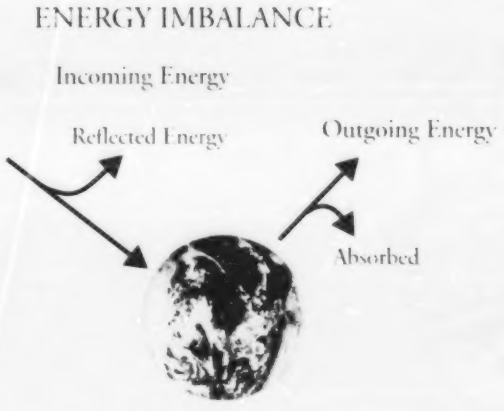


Figure 2. Greenhouse gas effect on the earth.

Source: Environment Canada

Table 1. Greenhouse gases covered by the Kyoto Protocol.

Source: A Guide to Kyoto: Climate Change and What It Means to Canadians. IISD. 1998.

Substance	Chemical symbol	Sources/Use	Damage to atmosphere	Lifespan
Carbon dioxide	CO_2	- occurs naturally - combustion of fossil fuels (coal, natural gas, petroleum) - deforestation (CO_2 released when trees decay or burn)	- United Nations estimates that CO_2 is currently responsible for over 60 per cent of the "enhanced" greenhouse effect, which is responsible for climate change	- calculations are imprecise because billions of tonnes of CO_2 are exchanged naturally each year - CO_2 levels varied by less than 10 per cent before industrialization - in the 200 years since 1800, levels have risen by almost 30 per cent
Nitrous oxide	N_2O	- occurs naturally - fertilizers - high temperature combustion of fossil fuels	- a molecule of N_2O is 200-300 times more effective than a molecule of CO_2 in greenhouse warming	- 150 years
Methane	CH_4	- occurs naturally - flooded rice paddies - farm animals - waste dumps - coal mining and natural gas production	- currently contributes 15–20 per cent of the enhanced greenhouse effect	- 11 to 12 years
Halocarbons - chlorofluorocarbons (CFCs) - hydrochlorofluoro-carbons (HCFCs)	- multiple (there are many types)	- used to make foam, cleaners, aerosol sprays, and coolants for refrigeration and air conditioning equipment	- destroys ozone layer - contributes to the enhanced greenhouse effect	- up to 400 years
Perfluorocarbons (PFCs)	- multiple (there are many types)	- used in solvents (particularly for cleaning electronic equipment) and fire suppression equipment	- global warming potential is 5,000–10,000 times greater than CO_2	- 3,000–5,000 years
Sulphur hexafluoride	SF_6	- an insulating alternative to mineral oil or air in some high-voltage equipment as well as for water leak detection in cable cooling systems	- has a much greater green-house potential than CO_2, but concentrations in atmosphere are very low	- ongoing research

number of frost-free days and the range of crops available to producers. That said, most of Canada's agricultural regions should expect a reduction in summer precipitation, with extreme declines of 10 to 20 per cent occurring in Manitoba. There is also a potential for increased animal and plant heat stress because of climate change.

The models predicted less significant increases in fall temperatures across Canada, ranging from two to three degrees C, perhaps leading to more frost-free days. Fall precipitation will be varied across the country, with increases in the northern regions and decreases in the south. Southern British Columbia has a potential increase of 20 per cent. The decreasing precipitation in southern Ontario could prove to be harmful because the recharging of soil moisture is needed for plant growth.

Winter will see the most significant temperature increases across Canada, according to the model. With a predicted increase between five and eight degrees C in Manitoba, there could be significant consequences for agriculture, transportation and energy demands.

Modelling Climate Change through General Circulation Models

Determining the regional impacts of climate change is an imprecise science. Although past and ongoing climate trends are useful to understand, developing future climate scenarios can help predict some of the regional consequences of climate change. The only means of looking to the future is the use of General Circulation Models (GCMs) as tools in generating climate change scenarios. Where GCM projections are similar to recently observed trends, greater confidence can be attached to the future outlooks.

General Circulation Models are powerful, computer-based, three-dimensional representations of the global climate system that project responses of climate to changing conditions, such as the concentration of greenhouse gases.[3] They are based on fundamental laws of physics and conservation of mass, momentum and energy, simplifying the complex climate system to a series of mathematical expressions. The three commonly used models agree on the direction of change in temperature and are usually fairly close to each other on the magnitude of change. Most of the GCMs do not provide consistent predictions on precipitation, but all suggest changing precipitation patterns for most regions. The models also suggest conditions that could foster an increase in thunderstorms and hailstorms in most regions.

The most common scenario modeled is for an equivalent of doubling the pre-industrial atmospheric concentration of carbon dioxide, a condition expected to occur by 2030. Under this scenario, the average global temperature will increase 2–6 degrees C over the next century.

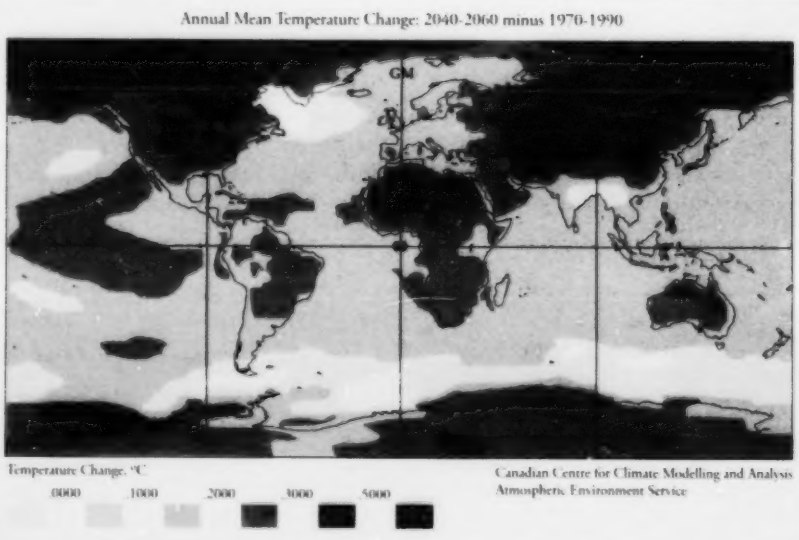


Figure 3. Projected global temperature changes.

Source: Canadian Centre for Climate Modelling and Analysis, Atmospheric Environment Services

3 Tyrchniewicz, A. and Choitti, Q. *Agriculture and Change: A Prairie Perspective*, IISD Working Paper, 1997.

number of frost-free days and the range of crops available to producers. That said, most of Canada's agricultural regions should expect a reduction in summer precipitation, with extreme declines of 10 to 20 per cent occurring in Manitoba. There is also a potential for increased animal and plant heat stress because of climate change.

The models predicted less significant increases in fall temperatures across Canada, ranging from two to three degrees C, perhaps leading to more frost-free days. Fall precipitation will be varied across the country, with increases in the northern regions and decreases in the south. Southern British Columbia has a potential increase of 20 per cent. The decreasing precipitation in southern Ontario could prove to be harmful because the recharging of soil moisture is needed for plant growth.

Winter will see the most significant temperature increases across Canada, according to the model. With a predicted increase between five and eight degrees C in Manitoba, there could be significant consequences for agriculture, transportation and energy demands.

Modelling Climate Change through General Circulation Models

Determining the regional impacts of climate change is an imprecise science. Although past and ongoing climate trends are useful to understand, developing future climate scenarios can help predict some of the regional consequences of climate change. The only means of looking to the future is the use of General Circulation Models (GCMs) as tools in generating climate change scenarios. Where GCM projections are similar to recently observed trends, greater confidence can be attached to the future outlooks.

General Circulation Models are powerful, computer-based, three-dimensional representations of the global climate system that project responses of climate to changing conditions, such as the concentration of greenhouse gases.[3] They are based on fundamental laws of physics and conservation of mass, momentum and energy, simplifying the complex climate system to a series of mathematical expressions. The three commonly used models agree on the direction of change in temperature and are usually fairly close to each other on the magnitude of change. Most of the GCMs do not provide consistent predictions on precipitation, but all suggest changing precipitation patterns for most regions. The models also suggest conditions that could foster an increase in thunderstorms and hailstorms in most regions.

The most common scenario modeled is for an equivalent of doubling the pre-industrial atmospheric concentration of carbon dioxide, a condition expected to occur by 2030. Under this scenario, the average global temperature will increase 2–6 degrees C over the next century.

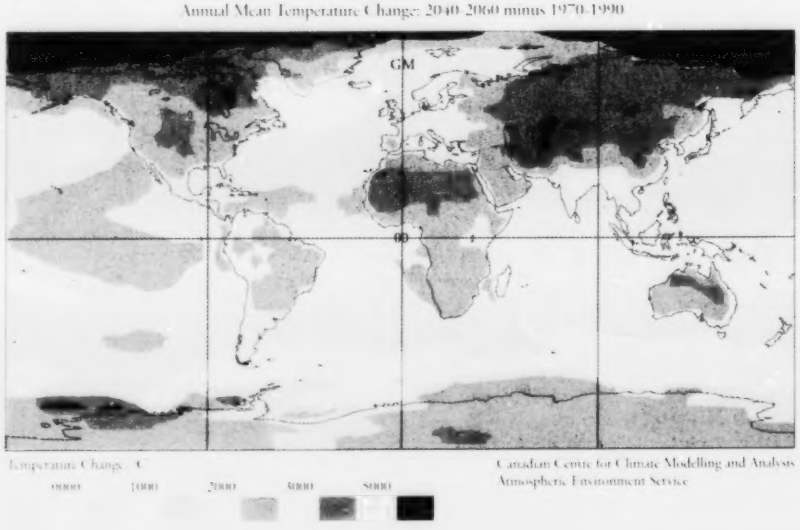


Figure 3. Projected global temperature changes.

Source: Canadian Centre for Climate Modelling and Analysis, Atmospheric Environment Services

3 Tyrchniewicz, A. and Choitti, Q. *Agriculture and Change: A Prairie Perspective*, IISD Working Paper, 1997.

Figure 4. Predicted changes in Canada's ecozones.

Source: Environment Canada

It is also likely that climate change will affect the frequency, severity and duration of extreme weather events.[4] Examples of possible increases, excluding nasty surprises, are:

- The frequency, duration and severity of extreme heat spells could increase significantly as the climate warms, while extreme cold spells might become less frequent.
- Thunderstorms and related hailstorms and tornadoes are expected to become more frequent and severe as the warmer surface temperatures cause the air to become more buoyant and rise into the atmosphere more rapidly (convection).
- The intensity of summer rainfall is expected to increase, also because of the increased convective activity.
- With a larger percentage of rain falling as intense events, the duration of dry periods between such events is likely to increase. Coupled with warmer temperatures, this suggests an increase in drought frequency and severity, particularly as defined by soil moisture.
- The number of intense winter storms might significantly increase.
- Major changes in the way water moves through the landscape, air and lakes and rivers could occur, as warmer temperatures will cause increased evaporation, more moisture in the air and, on average, more rain.
- Major changes in atmospheric circulation could take place, affecting storm tracks and rainfall distribution.

Manitoba is particularly sensitive and vulnerable to climate change because of the important role that renewable resources—like forests and agriculture—play in our economy. Manitoba is also home to vulnerable northern environments that are predicted to experience greater than average temperature changes. Manitoba will likely experience warmer and wetter winters and springs, and longer, warmer and drier summers. These changes could have massive impacts on Manitoba's ecozones. Figure 4 shows the expected shift mid-century in ecozones in Canada, assuming a doubling of greenhouse gases in the atmosphere, which is expected to take place by 2030.

Manitoba could face positive as well as negative impacts from climate change. With the warmer temperatures and longer growing season, a wider range of cropping options might be available for agriculture. However, the agriculture sector will also need to address risks related to a lack of water during the growing season and the

4 Herrington, R. *et al.*

likelihood of more pests and pest species. The increased temperatures in the winter could reduce the amount of winterkill of fall-seeded crops, but might also reduce the winterkill of some weeds and insects. Livestock will benefit from the warmer winter temperatures, but will be more vulnerable to heat stress during the summer months. More frequent winter thaws could trigger water and soil erosion.

Manitoba forests will be more susceptible to wildfires and pests during the summers and the forests' ideal habitat will be pushed further north. The concern is that the northern soils will not be able to support southern forest types until the soil develops further, which could take up to 10,000 years. As seen in Figure 4, climate change models predict an overall decrease in forest area because of moisture deficits in the south and lack of suitable soil in the north. Combined, these changes would cause the proportion of harvestable trees to immature trees to become increasingly skewed. There will be fewer mature trees to cut down and as the climate changes, it will take longer for trees in the boreal forest to reach a harvestable age. Eventually, the forestry industry will end up in serious danger as forest productivity drops.

Water quality in Manitoba might be in jeopardy because of the warmer temperatures and lower volumes in the summer. As the volume in surface water decreases, pollution levels increase. The increased spring volumes could also lead to higher levels of pollution, as land is flooded and manure and other storage facilities—like municipal lagoons—are breached. If the spring water is permitted to flow rapidly through to Hudson Bay, groundwater recharge might not occur enough to fully recharge the aquifers.

The increased summer temperatures, together with reduced precipitation and higher evaporation, might reduce the amount of water available for Manitoba's hydroelectric production. Manitoba's hydro resources could also be stretched as the result of greater electricity demand for air-conditioning during summers.

Northern communities could experience warmer temperatures throughout the year, which could increase their opportunities for economic development through potential increases in tourism and reduced operating costs due to warmer conditions. However, challenges could be in store for communities dependent on their natural surroundings, ice roads and other infrastructure over permafrost.

Economic development in many northern communities is associated with hunting and forestry, as well as other single-resource based activities. These activities are vulnerable to climate change. The changing conditions can lead to a shift in wildlife habitat which, when tied to potential unpredictable winter ice conditions, makes it more difficult for the residents to know what is safe. Municipal planning in the northern communities could also become more difficult with short seasons of ice roads, and melting permafrost in areas that were once stable. Runways built on permafrost will require greater maintenance as the permafrost melts.

There is a growing scientific concern that the long-term impacts of climate change might represent the greatest environmental health risk to humanity. While Manitobans are not likely to be threatened by malaria and other diseases, there are many significant public health issues. While making an accurate assessment is complex and unlikely, a consensus is emerging on the potential direct and indirect implications of climate change for human health. Direct impacts involve sickness and the loss of life from the increased frequency, severity and geographic extent of extreme climate events such as heat waves and floods. Indirect impacts include the spread of infectious diseases and the climate-influenced mass migration of people.

Researchers have long appreciated the role climate plays in disease distribution. The combined effects of the projected increases in temperature and rainfall suggest an expansion of favourable habitats for many diseases; regional changes from seasonal to perennial transmission; and the spread of vector-borne diseases such as Lyme disease into areas currently disease-free. Water quality could become a great concern for Manitobans because of potential increases in water borne transmission of diseases and bacteria. Air quality is another health issue because higher concentrations of airborne allergens like pollen and molds could lead to increased incidences of asthma and allergies.

The International and Canadian Responses to Climate Change

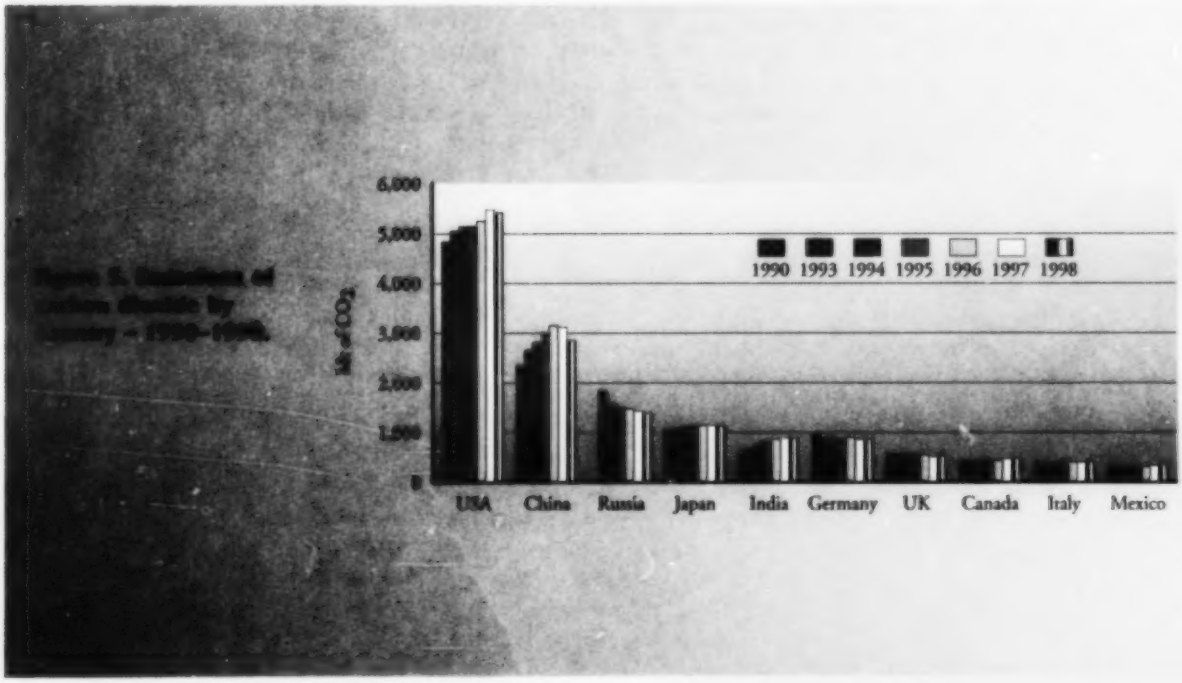
A Brief International History

Fifteen years ago, climate change was a little-known issue discussed by meteorologists and scientists at specialized conferences. Today, it is the focus of unprecedented efforts by governments, businesses, organizations, communities and individuals to arrange and coordinate their policies, economic activities and lifestyles to ensure a sustainable future. Apart from a string of hot years and wild weather, what brought climate change to the public consciousness?

In 1988, the World Meteorological Organization and the United Nations Environment Programme established the Intergovernmental Panel on Climate Change (IPCC), a body of several hundred of the world's top climate change scientists and experts. Its mandate is to review the science of climate change, study the environmental impacts and the socio-economic effects, and develop response strategies to address the problem and adapt to the changing environment. Through its three working groups, the IPCC produced reports on these issues and is now considered the leading scientific authority on climate change. In particular, the IPCC has produced three Assessment Reports—in 1990, 1995 and 2001—which contain predictions and scenarios for the extent of climate change over the 21st century, detailed assessments of climate change vulnerability, impacts and adaptation needs at the regional level, and analyses of mitigation options.[5]

Meanwhile, governments got together through the United Nations to give shape to an international set of rules to combat climate change. At the 1992 Earth Summit in Rio de Janeiro, 150 countries agreed to the United Nations Framework Convention on Climate Change (UNFCCC). In doing so, they acknowledged the need for preventative, precautionary action to slow climate change by limiting emissions of human-made greenhouse gases.

5 All IPCC reports can be found on the IPCC's web site: http://www.ipcc.ch



The International and Canadian Responses to Climate Change

A Brief International History

Fifteen years ago, climate change was a little-known issue discussed by meteorologists and scientists at specialized conferences. Today, it is the focus of unprecedented efforts by governments, businesses, organizations, communities and individuals to arrange and coordinate their policies, economic activities and lifestyles to ensure a sustainable future. Apart from a string of hot years and wild weather, what brought climate change to the public consciousness?

In 1988, the World Meteorological Organization and the United Nations Environment Programme established the Intergovernmental Panel on Climate Change (IPCC), a body of several hundred of the world's top climate change scientists and experts. Its mandate is to review the science of climate change, study the environmental impacts and the socio-economic effects, and develop response strategies to address the problem and adapt to the changing environment. Through its three working groups, the IPCC produced reports on these issues and is now considered the leading scientific authority on climate change. In particular, the IPCC has produced three Assessment Reports—in 1990, 1995 and 2001—which contain predictions and scenarios for the extent of climate change over the 21st century, detailed assessments of climate change vulnerability, impacts and adaptation needs at the regional level, and analyses of mitigation options.[5]

Meanwhile, governments got together through the United Nations to give shape to an international set of rules to combat climate change. At the 1992 Earth Summit in Rio de Janeiro, 150 countries agreed to the United Nations Framework Convention on Climate Change (UNFCCC). In doing so, they acknowledged the need for preventative, precautionary action to slow climate change by limiting emissions of human-made greenhouse gases.

5 All IPCC reports can be found on the IPCC's web site: http://www.ipcc.ch

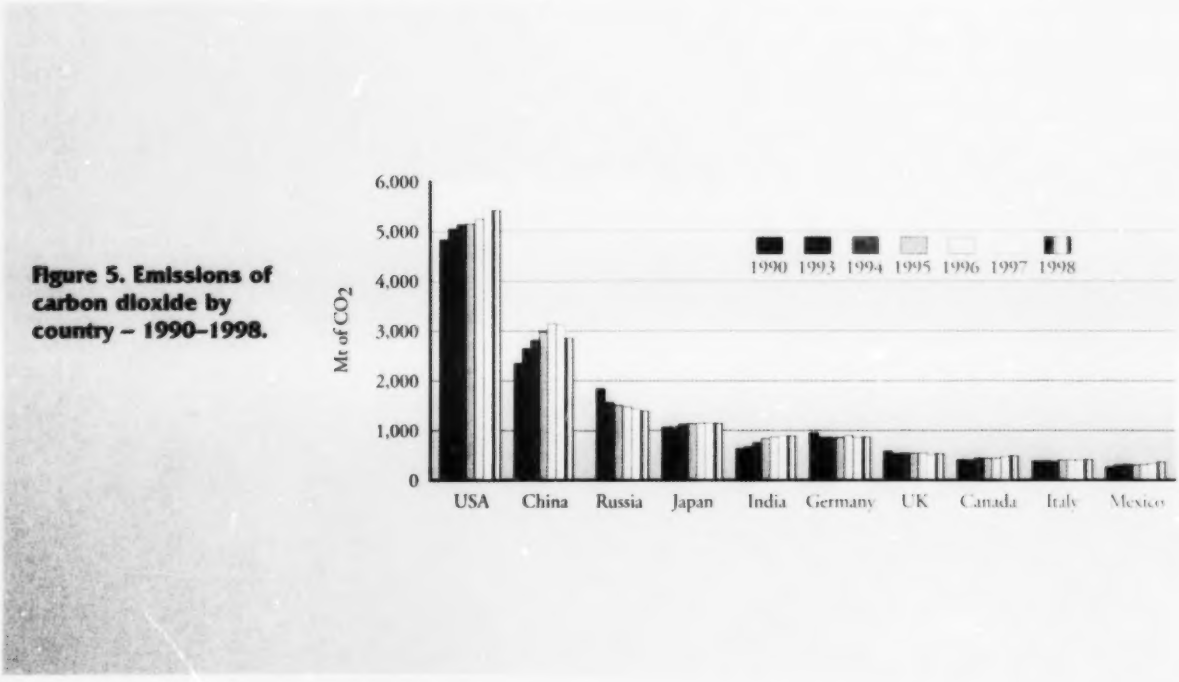


Figure 5. Emissions of carbon dioxide by country – 1990–1998.

The ultimate goal of the UNFCCC is to achieve stabilization of greenhouse gas concentrations in the atmosphere "at a level that would prevent dangerous anthropogenic [human-caused] interference with the climate system.[6]" To achieve this, the treaty outlined a framework for action to control or cut greenhouse gas emissions. It divided the world into developing and industrialized countries and required the latter group of countries, including Canada, to implement actions with the aim of stabilizing emissions at 1990 levels by 2000.

The UNFCCC came into force in 1994. It was immediately apparent, for a number of reasons, that the commitments under the UNFCCC would not be sufficient in addressing climate change: the treaty did not cover major developing country emitters, such as China, Brazil or India; the stabilization goal among industrialized countries, even if met, would not solve the problem; and a significant number of countries, including Canada and the United States, were not able to achieve even those modest emissions reduction goals. In 1995, the IPCC released its Second Assessment Report containing a strong message on the expected level of global warming and extent to which it is caused by human activity. Countries then began to negotiate towards a protocol to the Convention that would contain tougher, legally-binding emissions reduction targets.

In December 1997 in Kyoto, Japan, those negotiations culminated in the Kyoto Protocol to the UNFCCC. Under the Protocol, developed countries agreed to reduce their overall emissions of six major greenhouse gases to 5.2 per cent below 1990 levels by 2008–2012. This overall target was translated into individual targets for each industrialized country. Canada, for example, committed to reduce its emissions by six per cent below 1990 levels. The U.S. and the European Union committed to reductions of seven and eight per cent respectively.

On the surface these do not seem like onerous targets. They are only a first step in achieving the UNFCCC's goal of stabilizing greenhouse gas concentrations in the atmosphere at a level that would minimize human-induced climate change. But the Protocol is extraordinarily significant in that it aims, in effect, to de-link economic growth and fossil fuel use, thereby reversing the trend followed by industrialized countries since the Industrial Revolution. This is no easy task. In nearly all developed countries, greenhouse gas emissions have been increasing sharply since 1990 and most "business-as-usual" scenarios predict continued strong growth. As a result, most countries will need to achieve a complete reversal of emissions rates—and reductions in the order of 20 to 30 per cent from business-as-usual—if they want to meet their targets. The extent of change mandated by the Kyoto Protocol makes it not only an important environmental agreement, but also arguably the most far-reaching economic treaty ever negotiated by the global community. As such, the devil is in the details, and those details have been the subject of protracted and often acrimonious negotiations since 1997.

Resolving the political issues in the Kyoto Protocol will not be straightforward. The most recent negotiations, held in The Netherlands in November 2000, collapsed after governments failed to agree on any of the issues outlined above. Since most countries will not ratify the Protocol until these issues are well on their way to resolution, the prospects for the new regime are tenuous.

6 United Nations Framework Convention on Climate Change, 1992, Article 2.

Outstanding Issues in the International Climate Negotiations

There are four major political issues in the climate change negotiations on which countries cannot agree. One point of contention is the three market-based mechanisms that developed countries negotiated to help them to meet their targets at the lowest possible cost. These "Kyoto mechanisms" provide various ways for entities in developed countries to purchase credits for emissions reductions effected in other parts of the world. The principle behind these mechanisms is that the atmosphere does not care where in the world the emissions are reduced; the effect is the same. So countries—and businesses—that have targets might as well make the emissions cuts where the cheapest opportunities exist. Many businesses, for example, will find it cheaper to invest in modernizing crumbling infrastructure in Russia or improving energy efficiency in China than making more expensive cuts at home. These three mechanisms are intended, under the Protocol, to supplement a range of domestic policies and measures that would stimulate emissions reductions in each industrialized country. The extent to which countries can trade their way to their emissions target remains controversial, with some countries pushing for a concrete limit to emissions trading in order to ensure actual cuts in emissions in each industrialized country.

The Kyoto Protocol allows countries to meet part of their target by increasing the amount of carbon that is absorbed from the atmosphere by carbon "sinks," such as forests, on their territory. It also provides for future inclusion of other types of sinks, such as agricultural soils. Sequestering, or storing, carbon can be a very cost-efficient means to reduce net emissions. Several technical difficulties are associated with sinks, however, such as measuring the amount of carbon sequestered and ensuring it is not re-released through fires and other events. And there is concern that some countries, in particular the United States, might have such a large carbon sink that they can avoid reducing emissions at all in energy, transportation and industry.

Another issue bogging down the Kyoto Protocol is deciding what kind of penalties or consequences countries will face if they do not meet their targets. There are several options on the negotiating table, ranging from policy assistance to help a country meet its target, to "restoring" emissions from future commitment periods at a penalty rate, to trade sanctions and direct financial penalties. Ideally, the Protocol's compliance system would increase the likelihood that countries will try to meet their targets, thus levelling the economic playing field and maintaining the environmental integrity of the Kyoto Protocol. If the consequences of non-compliance are too harsh, countries that find it too difficult or expensive to comply might simply drop out of the treaty. If they are too weak, countries will have no incentive to reduce their emissions.

An even bigger political albatross around the neck of the climate change treaty is the participation of developing countries, who do not have emissions reduction targets. With 80 per cent of the world's population, developing countries are responsible for only 40 per cent of global greenhouse gas emissions. Industrialized countries, on the other hand, are responsible for 60 per cent of the annual emissions and 80 per cent of the historical build-up of greenhouse gases in the atmosphere. For these reasons, developing countries argue that leadership in tackling climate change should lie with industrialized countries. Many developed countries, particularly the U.S., counter that all countries except the very poorest must do their part, and that exempting major emitters like China from assuming an emissions reduction target will give developing country industries an unfair competitive advantage in international markets.

The ultimate goal of the UNFCCC is to achieve stabilization of greenhouse gas concentrations in the atmosphere "at a level that would prevent dangerous anthropogenic [human-caused] interference with the climate system.[6]" To achieve this, the treaty outlined a framework for action to control or cut greenhouse gas emissions. It divided the world into developing and industrialized countries and required the latter group of countries, including Canada, to implement actions with the aim of stabilizing emissions at 1990 levels by 2000.

The UNFCCC came into force in 1994. It was immediately apparent, for a number of reasons, that the commitments under the UNFCCC would not be sufficient in addressing climate change: the treaty did not cover major developing country emitters, such as China, Brazil or India; the stabilization goal among industrialized countries, even if met, would not solve the problem; and a significant number of countries, including Canada and the United States, were not able to achieve even those modest emissions reduction goals. In 1995, the IPCC released its Second Assessment Report containing a strong message on the expected level of global warming and extent to which it is caused by human activity. Countries then began to negotiate towards a protocol to the Convention that would contain tougher, legally-binding emissions reduction targets.

In December 1997 in Kyoto, Japan, those negotiations culminated in the Kyoto Protocol to the UNFCCC. Under the Protocol, developed countries agreed to reduce their overall emissions of six major greenhouse gases to 5.2 per cent below 1990 levels by 2008–2012. This overall target was translated into individual targets for each industrialized country. Canada, for example, committed to reduce its emissions by six per cent below 1990 levels. The U.S. and the European Union committed to reductions of seven and eight per cent respectively.

On the surface these do not seem like onerous targets. They are only a first step in achieving the UNFCCC's goal of stabilizing greenhouse gas concentrations in the atmosphere at a level that would minimize human-induced climate change. But the Protocol is extraordinarily significant in that it aims, in effect, to de-link economic growth and fossil fuel use, thereby reversing the trend followed by industrialized countries since the Industrial Revolution. This is no easy task. In nearly all developed countries, greenhouse gas emissions have been increasing sharply since 1990 and most "business-as-usual" scenarios predict continued strong growth. As a result, most countries will need to achieve a complete reversal of emissions rates—and reductions in the order of 20 to 30 per cent from business-as-usual—if they want to meet their targets. The extent of change mandated by the Kyoto Protocol makes it not only an important environmental agreement, but also arguably the most far-reaching economic treaty ever negotiated by the global community. As such, the devil is in the details, and those details have been the subject of protracted and often acrimonious negotiations since 1997.

Resolving the political issues in the Kyoto Protocol will not be straightforward. The most recent negotiations, held in The Netherlands in November 2000, collapsed after governments failed to agree on any of the issues outlined above. Since most countries will not ratify the Protocol until these issues are well on their way to resolution, the prospects for the new regime are tenuous.

6 United Nations Framework Convention on Climate Change, 1992, Article 2.

Outstanding Issues in the International Climate Negotiations

There are four major political issues in the climate change negotiations on which countries cannot agree. One point of contention is the three market-based mechanisms that developed countries negotiated to help them to meet their targets at the lowest possible cost. These "Kyoto mechanisms" provide various ways for entities in developed countries to purchase credits for emissions reductions effected in other parts of the world. The principle behind these mechanisms is that the atmosphere does not care where in the world the emissions are reduced; the effect is the same. So countries—and businesses—that have targets might as well make the emissions cuts where the cheapest opportunities exist. Many businesses, for example, will find it cheaper to invest in modernizing crumbling infrastructure in Russia or improving energy efficiency in China than making more expensive cuts at home. These three mechanisms are intended, under the Protocol, to supplement a range of domestic policies and measures that would stimulate emissions reductions in each industrialized country. The extent to which countries can trade their way to their emissions target remains controversial, with some countries pushing for a concrete limit to emissions trading in order to ensure actual cuts in emissions in each industrialized country.

The Kyoto Protocol allows countries to meet part of their target by increasing the amount of carbon that is absorbed from the atmosphere by carbon "sinks," such as forests, on their territory. It also provides for future inclusion of other types of sinks, such as agricultural soils. Sequestering, or storing, carbon can be a very cost-efficient means to reduce net emissions. Several technical difficulties are associated with sinks, however, such as measuring the amount of carbon sequestered and ensuring it is not re-released through fires and other events. And there is concern that some countries, in particular the United States, might have such a large carbon sink that they can avoid reducing emissions at all in energy, transportation and industry.

Another issue bogging down the Kyoto Protocol is deciding what kind of penalties or consequences countries will face if they do not meet their targets. There are several options on the negotiating table, ranging from policy assistance to help a country meet its target, to "restoring" emissions from future commitment periods at a penalty rate, to trade sanctions and direct financial penalties. Ideally, the Protocol's compliance system would increase the likelihood that countries will try to meet their targets, thus levelling the economic playing field and maintaining the environmental integrity of the Kyoto Protocol. If the consequences of non-compliance are too harsh, countries that find it too difficult or expensive to comply might simply drop out of the treaty. If they are too weak, countries will have no incentive to reduce their emissions.

An even bigger political albatross around the neck of the climate change treaty is the participation of developing countries, who do not have emissions reduction targets. With 80 per cent of the world's population, developing countries are responsible for only 40 per cent of global greenhouse gas emissions. Industrialized countries, on the other hand, are responsible for 60 per cent of the annual emissions and 80 per cent of the historical build-up of greenhouse gases in the atmosphere. For these reasons, developing countries argue that leadership in tackling climate change should lie with industrialized countries. Many developed countries, particularly the U.S., counter that all countries except the very poorest must do their part, and that exempting major emitters like China from assuming an emissions reduction target will give developing country industries an unfair competitive advantage in international markets.

Businesses and Environmental Groups on the International Climate Change Scene

One thing is clear: even without an agreement to implement the Kyoto Protocol, the issue of climate change will not go away for one very simple reason—the international process has successfully catapulted the problem of climate change onto virtually every other agenda. In fact, governments' participation in this issue has often been overtaken by businesses, non-governmental organizations, communities and individuals who have recognized the need to prepare for a carbon-constrained future and have already begun to act.

Prior to the negotiations in Kyoto in 1997, few businesses or industry associations paid much attention to climate change. A handful watched developments cautiously while others lobbied their governments against any kind of treaty on the grounds that the science was unsound and the economic costs would be unacceptable.

But competing signals began to emerge as early as May 1997. British Petroleum CEO Sir John Browne, in a speech at Stanford University, broke ranks with the oil industry by acknowledging the role of fossil fuels in the buildup of greenhouse gases and the need to address the problem of global warming. Then the French oil group Elf Aquitaine pledged to cut its emissions by 15 per cent of 1990 levels by 2010. In 1998, executives from major oil companies such as Royal Dutch/Shell Group, Texaco and Sun Oil Co. publicly acknowledged that fossil fuels might be changing the climate and suggested that companies begin focusing on how to reduce greenhouse gas emissions.

The World Business Council for Sustainable Development created its Climate and Energy program to explore ways for businesses to manage risk and mitigate their emissions. In May, 1998, the Pew Center on Climate Change was established with a number of major corporate participants, including Boeing; Lockheed-Martin; Toyota; Maytag and Whirlpool; United Technologies and 3M; British Petroleum; Sun Oil; American Electric Power; U.S. Generating Co.; Enron, Ontario Power Generation; and Trans-Alta Utilities. They are all committed to seek ways to reduce their own emissions and to invest in more efficient products and technologies.

Companies also began to initiate forestry projects to offset their emissions, set voluntary reduction targets, and undertake work on cleaner technologies, such as solar energy, wind energy and hydrogen fuel cells to power automobiles. Companies also began to engage in external carbon trades and pilot projects in anticipation of the introduction of emissions trading systems. Some were faced with stockholder resolutions that would require them to examine the impacts of their policies on global warming. Battered by a suite of extreme weather events in the 1990s, the insurance industry stepped up its lobbying efforts calling for action on climate change.

At the same time, the concept of emissions trading took root with the establishment of many public and private "carbon" funds. These are similar to mutual funds, except that the pool of funds from various investors is put into projects that reduce greenhouse gas emissions. Investors can use the emissions reduction credits that are generated from the projects to comply with their target or to sell to someone else who needs them. Notable among these carbon funds is the World Bank's Prototype Carbon Fund, capitalized by private companies and governments. Meanwhile, governments considered or established pilot emissions trading projects in cooperation with firms, while companies such as BP and Shell implemented internal emissions trading schemes. Major brokerages, banks and consulting firms launched sophisticated web sites to help companies manage carbon risks, reduce emissions and participate in trading.

Many large corporations have formed coalitions with environmental groups to enhance the credibility of their efforts to tackle climate change. Early in 2001, seven large energy and manufacturing corporations announced a voluntary partnership to reduce emissions of greenhouse gases, with the results to be monitored by Environmental Defense, a U.S.-based environmental organization. Polaroid Corporation agreed to

What is "Emissions Trading?"

Emissions trading is a policy tool that caps emissions at a reduced level to ensure environmental results and uses market-based incentives to lower the cost of environmental control. It works like this: each emitter (or company) is assigned an emissions allowance, usually calculated in tonnes of CO_2. A company that can reduce its emissions quite cheaply has a cash incentive to do better than its allowance, because it can sell the excess emissions allowance to a company whose costs are higher. Thus, where the cost of controlling emissions differs from source to source, emissions trading lowers the cost of meeting emissions targets. Emissions trading is not limited to companies, though. Under the Kyoto Protocol, countries with targets will also be able to trade their allowances. Since greenhouse gases are global pollutants, the environmental impact of reducing them is the same no matter where the reductions take place. The same overall reduction is achieved, total costs are reduced and buyers and sellers gain from the savings allowed by trading.

cut carbon dioxide emissions by 25 per cent in the next 10 years and switch to cleaner fuels and technology as part of the "Climate Savers Program," of the World Wildlife Fund. The U.S.-based World Resources Institute has undertaken a program with a number of business associations and corporations to develop an international protocol for measuring and reporting corporate greenhouse gas emissions.

Non-governmental organizations also have stepped up their efforts to promote awareness of and solutions to climate change. A huge proportion of the body of knowledge on climate change impacts, adaptation and mitigation strategies has been produced by think tanks, policy research organizations and university research centres. The Climate Change Knowledge Network, which involves 14 research organizations from developing and developed countries, is one example of how such organizations are working together to develop policies and projects that bridge international political and economic divides. The International Institute for Sustainable Development, headquartered in Winnipeg, is the coordinator of this network. Environmental advocacy groups have also been extremely active at every level promoting action on climate change. Several hundred such organizations have united under the umbrella of the Climate Action Network, which, through offices throughout the world, works to raise public awareness and influence the outcome of negotiations over the Kyoto Protocol.

Canada's Role

Canada contributes approximately two per cent of global greenhouse gas emissions—a contribution that appears modest but, given our small population, actually represents a significant part of the problem. While Canada has taken big steps in improving the energy efficiency of its production and industrial processes, it remains the second highest per capita producer of greenhouse gas emissions among major industrialized countries.

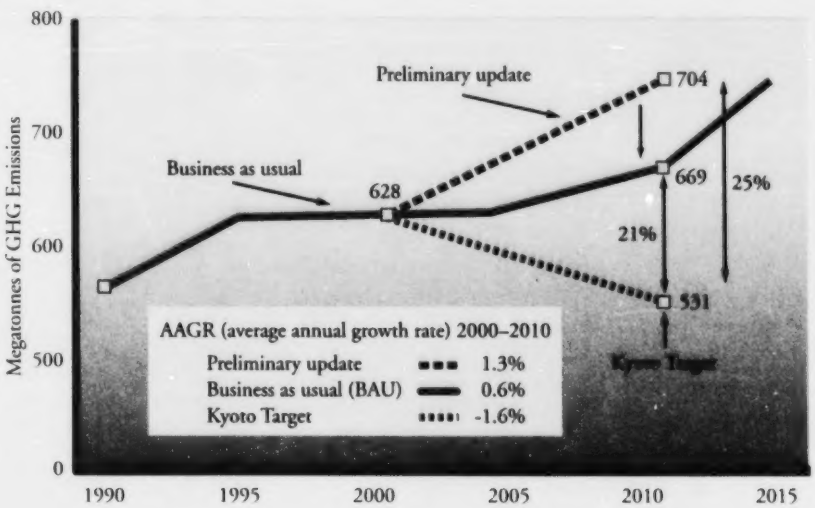


Figure 6. Canada's Kyoto Protocol challenge.

Source: Natural Resources Canada

What is "Emissions Trading?"

Emissions trading is a policy tool that caps emissions at a reduced level to ensure environmental results and uses market-based incentives to lower the cost of environmental control. It works like this: each emitter (or company) is assigned an emissions allowance, usually calculated in tonnes of CO_2. A company that can reduce its emissions quite cheaply has a cash incentive to do better than its allowance, because it can sell the excess emissions allowance to a company whose costs are higher. Thus, where the cost of controlling emissions differs from source to source, emissions trading lowers the cost of meeting emissions targets. Emissions trading is not limited to companies, though. Under the Kyoto Protocol, countries with targets will also be able to trade their allowances. Since greenhouse gases are global pollutants, the environmental impact of reducing them is the same no matter where the reductions take place. The same overall reduction is achieved, total costs are reduced and buyers and sellers gain from the savings allowed by trading.

cut carbon dioxide emissions by 25 per cent in the next 10 years and switch to cleaner fuels and technology as part of the "Climate Savers Program," of the World Wildlife Fund. The U.S.-based World Resources Institute has undertaken a program with a number of business associations and corporations to develop an international protocol for measuring and reporting corporate greenhouse gas emissions.

Non-governmental organizations also have stepped up their efforts to promote awareness of and solutions to climate change. A huge proportion of the body of knowledge on climate change impacts, adaptation and mitigation strategies has been produced by think tanks, policy research organizations and university research centres. The Climate Change Knowledge Network, which involves 14 research organizations from developing and developed countries, is one example of how such organizations are working together to develop policies and projects that bridge international political and economic divides. The International Institute for Sustainable Development, headquartered in Winnipeg, is the coordinator of this network.

Environmental advocacy groups have also been extremely active at every level promoting action on climate change. Several hundred such organizations have united under the umbrella of the Climate Action Network, which, through offices throughout the world, works to raise public awareness and influence the outcome of negotiations over the Kyoto Protocol.

Canada's Role

Canada contributes approximately two per cent of global greenhouse gas emissions—a contribution that appears modest but, given our small population, actually represents a significant part of the problem. While Canada has taken big steps in improving the energy efficiency of its production and industrial processes, it remains the second highest per capita producer of greenhouse gas emissions among major industrialized countries.

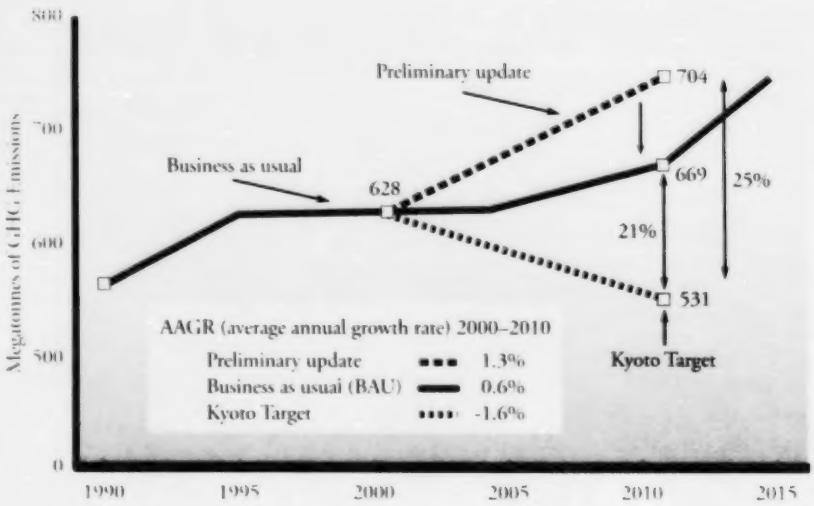
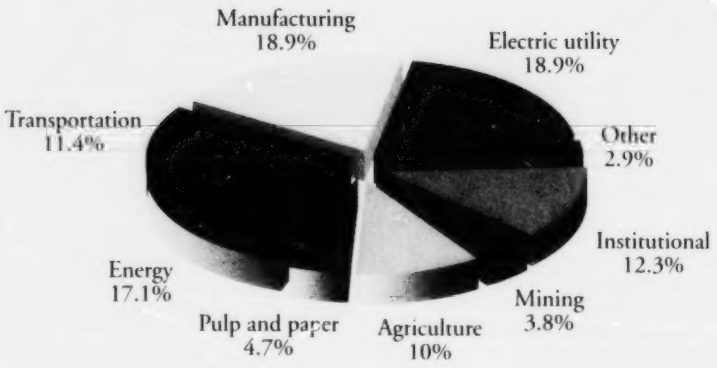


Figure 6. Canada's Kyoto Protocol challenge.

Source: Natural Resources Canada

Figure 7. Canadian greenhouse gas emissions by sector.

Source: Natural Resources Canada: Canada's Energy Outlook 1996-2020



While this can partially be attributed to unique circumstances, particularly around Canada's climate, geography, population and economic structure, Canada has rightfully committed to do its part by agreeing, in the Kyoto Protocol, to reduce its emissions by six per cent from 1990 levels by 2008–2012. Like all other industrialized countries, the Canadian government has yet to ratify the Protocol. Ratification will likely only occur when the government, in consultation with provinces and stakeholders, has developed a national plan that will specifically lay out the policies and measures Canada will adopt in order to reach its target. Due in no small part to close and active trade relations with the United States, the actions our neighbour to the south takes to meet its own Kyoto target will also undoubtedly play a critical role in determining prospects for Canada ratifying the Protocol.

In response to the Kyoto Protocol, the federal government established a National Climate Change Secretariat. The Secretariat launched a series of intensive consultations with stakeholders and provinces referred to as the National Climate Change Process. In total, 16 Climate Change Issue Tables were established, covering all relevant sectors and issues.

Each Table was required to produce a state of the sector report, referred to as a Foundation Paper, as well as an Options Report, outlining potential strategies to reduce GHG emissions in each sector. Membership of each Table included the private sector, governments, universities and non-government organizations. The Table reports were synthesized into a comprehensive document outlining the sources of emissions and opportunities to reduce emissions from each sector.

These reports, along with extensive consultations between federal, provincial, territorial and municipal governments, fed into a comprehensive federal strategy to reduce GHG emissions called "Action Plan 2000," which is available at the National Climate Change Process web site (http://www.nccp.ca). Each province is currently developing its own strategies to address climate change and complement the federal plan. The provincial action plans that are completed are also included on the web site. Manitoba is in the process of developing a strategy and has recently committed to finish a first draft of the Plan by the end of 2001.

Action Plan 2000 targets key sectors that account for over 90 per cent of Canada's greenhouse gas emissions. Those sectors are transportation, energy (oil and gas production and electricity), industry, buildings, forestry and agriculture. The Plan also includes support for technology development, science and adaptation, and emissions-reducing projects in other countries. The initiatives outlined in the Plan will take Canada one third of the way towards meeting its Kyoto target. It will also provide other benefits to Canadians, such as cost economic savings from improvements in energy efficiency and health benefits from cleaner air.[7]

7 Government of Canada. *Government of Canada Action Plan 2000 on Climate Change.* Government of Canada: 2000.

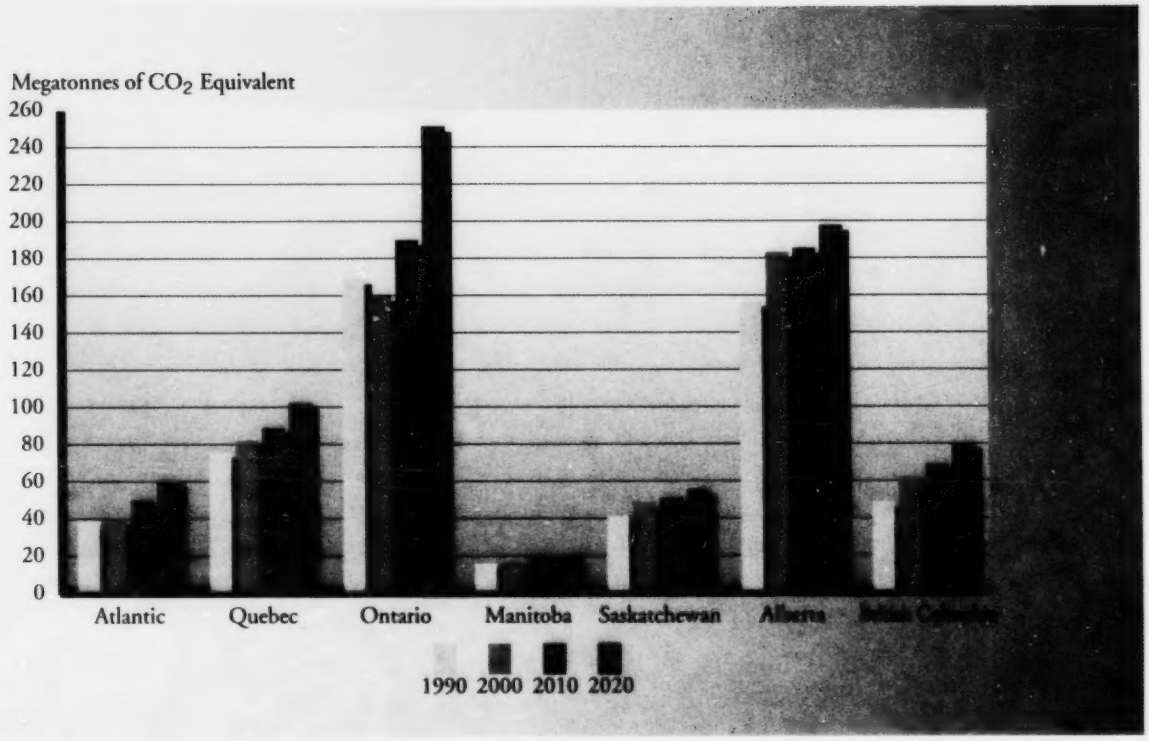


Figure 8. Provincial greenhouse gas emissions.

Source: Natural Resources Canada

Figure 8 outlines the emissions from most provinces and demonstrates the challenge Canada will face in reducing its greenhouse gas emissions by more than 25 per cent from "Business as Usual" projections.

Industry, Environmental Groups and Municipalities on the Canadian Climate Change Scene

Over the past five to 10 years, Canadian businesses, communities and environmental groups have become increasingly engaged in addressing climate change. Businesses have focused largely on developing voluntary and market-based approaches to reducing their emissions. Individual corporations typically count on a range of measures to curb their overall emissions, including improving their energy efficiency, installing new technology and reducing their customers' emissions by making more energy-efficient products.

In addition, many companies are exploring the possibility of buying and selling emissions units in Canada and overseas. The idea is that companies can reduce emissions outside their main operations and that these efforts can be translated into tradable paper emission credits or "offsets." Offsets can be generated in several ways: doing much better than one's GHG target and selling the unused emissions allowances through emissions trading,

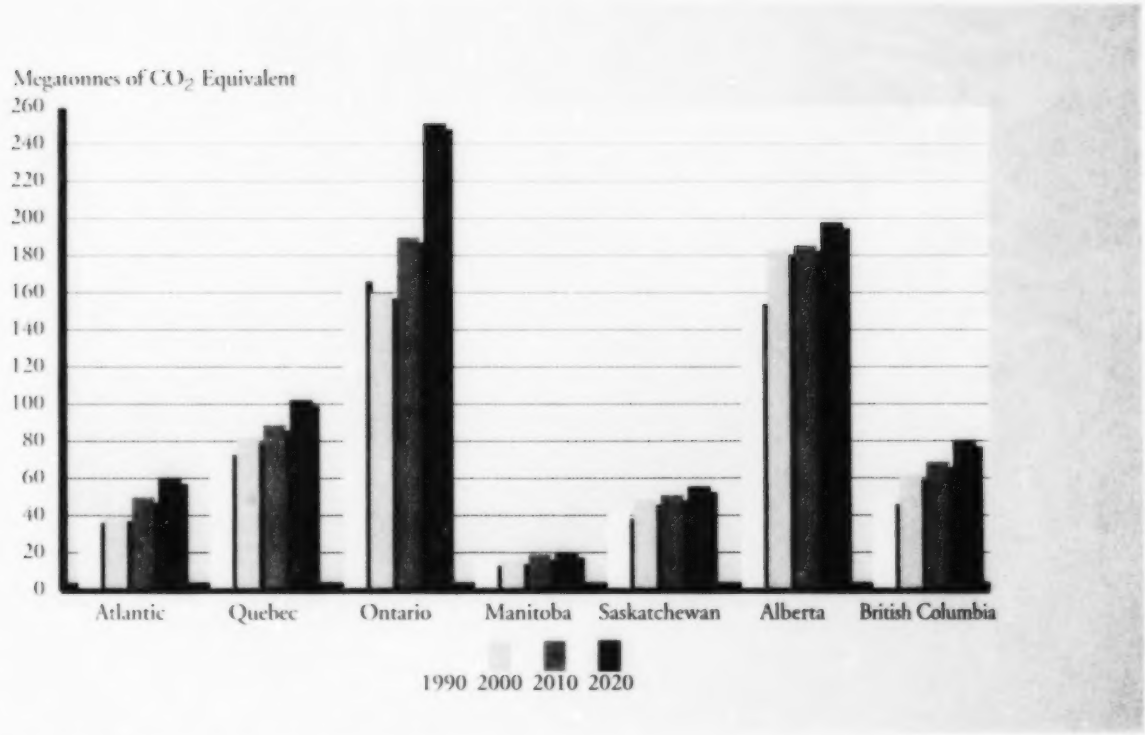


Figure 8. Provincial greenhouse gas emissions.

Source: Natural Resources Canada

Figure 8 outlines the emissions from most provinces and demonstrates the challenge Canada will face in reducing its greenhouse gas emissions by more than 25 per cent from "Business as Usual" projections.

Industry, Environmental Groups and Municipalities on the Canadian Climate Change Scene

Over the past five to 10 years, Canadian businesses, communities and environmental groups have become increasingly engaged in addressing climate change. Businesses have focused largely on developing voluntary and market-based approaches to reducing their emissions. Individual corporations typically count on a range of measures to curb their overall emissions, including improving their energy efficiency, installing new technology and reducing their customers' emissions by making more energy-efficient products.

In addition, many companies are exploring the possibility of buying and selling emissions units in Canada and overseas. The idea is that companies can reduce emissions outside their main operations and that these efforts can be translated into tradable paper emission credits or "offsets." Offsets can be generated in several ways: doing much better than one's GHG target and selling the unused emissions allowances through emissions trading,

implementing projects abroad that reduce emissions against a set baseline, or planting or preserving a forest that absorbs carbon dioxide. Thus, an organization could reduce its "net" GHG emissions—emissions from its own operations minus offsets purchased—by making the reductions where it is cheapest to make them.

Industry has played a key role in establishing several Canadian organizations and programs whose goals are to create a better understanding about how these market-based approaches might work. In 1996, 10 companies formed the not-for-profit Greenhouse Gas Emission Management Consortium (GEMCo). The Pilot Emissions Reduction Trading Project (PERT) was established the same year, and the Greenhouse Gas Emissions Reduction Trading Pilot (GERT) was established in 1998 at the initiative of the province of British Columbia. These programs aim to provide their participants with practical experience in emissions trading and to evaluate trading as a tool to assist in the reduction of GHG emissions. Over 50 corporations, environmental organizations and government departments are members of PERT; GERT's roughly two dozen members include industry associations, environmental groups, and federal and provincial government departments.

A number of Canadian corporations have developed and implemented climate change action plans, which have been set out in their public reporting of environmental or sustainable development performance. Early leaders include TransAlta, Suncor, Ontario Power Generation and Shell Canada. A number of other corporations, such as BP and DuPont, are pursuing the climate change targets of their international parent companies. These action plans have been a cornerstone of the voluntary approach to GHG emissions management pioneered by Canada's Climate Change Voluntary Challenge and Registry (VCR).

Environmental and public-interest groups have been remarkably active in researching and analyzing policy options, promoting government action on climate change, educating Canadians about the issue and collaborating with industry to find ways to reduce GHG emissions. Organizations such as the Pembina Institute for Appropriate Development, West Coast Environmental Law, the Sierra Club of Canada and the Winnipeg-based International Institute for Sustainable Development have participated in the national Issues Table process, in consultation committees to advise the federal government and even, alongside their industry counterparts, on the Canadian delegation to the international climate change negotiations.

Canada's Climate Change Voluntary Challenge and Registry

Voluntary Challenge and Registry Inc. (VCR Inc.) is a stand-alone corporation dedicated to encouraging—or challenging—private and public sector organizations in Canada to voluntarily limit their greenhouse gas emissions. After a period of incubation as a government program, VCR was incorporated as an independent entity in 1997 and became a public-private partnership drawing funds from corporations as well as federal and provincial governments.

The Registry component of VCR Inc.'s operations records the actions planned and executed by its registrants, providing them with the opportunity to exchange information and to share best practices with their peers. Registrants currently represent over 75 per cent of greenhouse gas emissions from business and industrial sources in Canada. As of March 2001, 760 organizations from all sectors of the economy had registered action plans with VCR Inc., including the federal government and all provincial governments. VCR Inc. provides guidelines and a reporting template to organizations wishing to develop and register their GHG action plans.

In October 2000, VCR Inc. introduced the Champions in Action Initiative. Under this plan, participating companies, associations, municipalities, governments and other entities will enter into voluntary agreements with performance targets for Canadian entity-wide, "net" GHG emission reductions. VCR Inc. will then review, approve, track and report over time, the achievement of these agreements. The aim of the Champions in Action Initiative is to provide Canadian organizations and governments with the ability to test the design and implementation of the voluntary target approach.

implementing projects abroad that reduce emissions against a set baseline, or planting or preserving a forest that absorbs carbon dioxide. Thus, an organization could reduce its "net" GHG emissions—emissions from its own operations minus offsets purchased—by making the reductions where it is cheapest to make them.

Industry has played a key role in establishing several Canadian organizations and programs whose goals are to create a better understanding about how these market-based approaches might work. In 1996, 10 companies formed the not-for-profit Greenhouse Gas Emission Management Consortium (GEMCo). The Pilot Emissions Reduction Trading Project (PERT) was established the same year, and the Greenhouse Gas Emissions Reduction Trading Pilot (GERT) was established in 1998 at the initiative of the province of British Columbia. These programs aim to provide their participants with practical experience in emissions trading and to evaluate trading as a tool to assist in the reduction of GHG emissions. Over 50 corporations, environmental organizations and government departments are members of PERT; GERT's roughly two dozen members include industry associations, environmental groups, and federal and provincial government departments.

A number of Canadian corporations have developed and implemented climate change action plans, which have been set out in their public reporting of environmental or sustainable development performance. Early leaders include TransAlta, Suncor, Ontario Power Generation and Shell Canada. A number of other corporations, such as BP and DuPont, are pursuing the climate change targets of their international parent companies. These action plans have been a cornerstone of the voluntary approach to GHG emissions management pioneered by Canada's Climate Change Voluntary Challenge and Registry (VCR).

Environmental and public-interest groups have been remarkably active in researching and analyzing policy options, promoting government action on climate change, educating Canadians about the issue and collaborating with industry to find ways to reduce GHG emissions. Organizations such as the Pembina Institute for Appropriate Development, West Coast Environmental Law, the Sierra Club of Canada and the Winnipeg-based International Institute for Sustainable Development have participated in the national Issues Table process, in consultation committees to advise the federal government and even, alongside their industry counterparts, on the Canadian delegation to the international climate change negotiations.

Canada's Climate Change Voluntary Challenge and Registry

Voluntary Challenge and Registry Inc. (VCR Inc.) is a stand-alone corporation dedicated to encouraging—or challenging—private and public sector organizations in Canada to voluntarily limit their greenhouse gas emissions. After a period of incubation as a government program, VCR was incorporated as an independent entity in 1997 and became a public-private partnership drawing funds from corporations as well as federal and provincial governments.

The Registry component of VCR Inc.'s operations records the actions planned and executed by its registrants, providing them with the opportunity to exchange information and to share best practices with their peers. Registrants currently represent over 75 per cent of greenhouse gas emissions from business and industrial sources in Canada. As of March 2001, 760 organizations from all sectors of the economy had registered action plans with VCR Inc., including the federal government and all provincial governments. VCR Inc. provides guidelines and a reporting template to organizations wishing to develop and register their GHG action plans.

In October 2000, VCR Inc. introduced the Champions in Action Initiative. Under this plan, participating companies, associations, municipalities, governments and other entities will enter into voluntary agreements with performance targets for Canadian entity-wide, "net" GHG emission reductions. VCR Inc. will then review, approve, track and report over time, the achievement of these agreements. The aim of the Champions in Action Initiative is to provide Canadian organizations and governments with the ability to test the design and implementation of the voluntary target approach.

A few examples illustrate the diverse range of activities undertaken by non-governmental organizations to tackle climate change. The Clean Air Renewable Energy (CARE) coalition, an alliance of several major Canadian environmental groups and energy companies, formed in 2000. It has called on the federal government to introduce tax credits for individual consumers who purchase renewable energy and broaden the incentives to industry to research and develop "green" power technologies. In 1999–2000, the International Institute for Sustainable Development partnered with the Inuit community of Sachs Harbour on Banks Island, in a project that highlighted the disastrous effects of climate change in Canada's Arctic. The Pembina Institute for Appropriate Development has held workshops for journalists and is developing curricula on climate change for use in schools. And in February 2001, the David Suzuki Foundation released a report outlining concrete, sector-specific ideas for reducing GHG emissions in British Columbia.

Municipalities, too, have become increasingly engaged on the climate change issue over the past decade. In their own operations, municipal governments consume fuel and electricity for waste treatment, building operation, water distribution, fleet operation and wastewater treatment. Landfill sites emit methane, a powerful greenhouse gas. The Partners for Climate Protection (PCP) program is one way municipal governments can systematically reduce greenhouse gas emissions. PCP, a partnership between the Federation of Canadian Municipalities and the International Council for Local Environmental Initiatives, now has over 80 member municipal governments including Winnipeg, Swan River, The Pas and Virden in Manitoba. The goal of the program is to encourage municipalities to reduce their greenhouse gas emissions by 20 per cent in relation to 1990 levels within 10 years of joining the PCP program. Members are encouraged to take a sort of five-step program involving taking stock of greenhouse gas emissions in municipal operations and community-wide; setting a realistic target for reducing emissions; developing a local action plan together with community stakeholders, and then implementing it.

The Implications of Climate Change for Manitoba: Opportunities and Challenges

With the recent conclusions of the IPCC that the rate of climate change is going to be more severe than expected, it is crucial for Manitoba, as part of the national and global response, to develop a framework for action that shows serious intent in addressing the risk of climate change.

By being proactive in helping Canada meet its Kyoto target, Manitoba industries have an opportunity to develop new markets by becoming leaders in the development and diffusion of climate change friendly technologies. There are many excellent examples of large and small businesses in the province successfully capitalizing on the opportunities created in an environment that is placing greater emphasis on reducing greenhouse gas emissions. Business and industry can increase market share, gain competitive advantage and increase shareholder value by developing management plans that consider climate change. For example, approaching the challenge of emissions reductions through efficiencies across the entire manufacturing process, instead of seeking end-of-pipe solutions, has been shown time and time again to positively affect the bottom line. Manitoba has a number of critical competitive niches—in the energy and transportation sectors, for example—in addressing climate change that would work to enhance economic development opportunities in the province. Additionally, innovation should continue to be nurtured and promoted. There are a great many existing Manitoban business and industry networks perfect for highlighting success, communicating new government programs, exchanging information and creating new partnerships.

From a policy perspective, Manitoba needs to think about how it could reduce its current greenhouse gas

emissions, as well as adapt to the new climate conditions. Manitoba's GHG emissions are among the lowest in Canada, mainly because of its vast hydro-electricity resources and the fact that there are few large carbon-based manufacturing facilities in the province. By promoting increased eco-efficiency (reducing the number of resource inputs and waste outputs), business and industry can make significant economic and competitive gains over their peers in other provinces. This is an opportunity to see the province develop a stronger economy by reacting early and strategically to climate change. Manitoba also needs to identify which private and public institutions are best suited to deliver cost-effective GHG reduction and sequestration opportunities.

Manitoba greenhouse gas emissions are different from other provinces' because of lower energy emissions and a higher ratio of emissions from agriculture. To illustrate: emissions can be broken down into four major areas: agriculture, transportation, residential and industrial activity. The agriculture emissions are made up from 65 per cent nitrous oxide, mainly from fertilizer and soil tillage, 30 per cent methane, mainly from livestock, and four per cent carbon dioxide. This is very different from the other three sectors, where the vast majority of GHG emissions are in the form of carbon dioxide.

Taking action now to begin adapting to the threat of climate change will work to minimize costs for future generations. It is more effective and less expensive to adapt to climate change over time rather than being forced to adopt more extreme, emergency adaptation techniques in the future when the best solutions are not necessarily available.

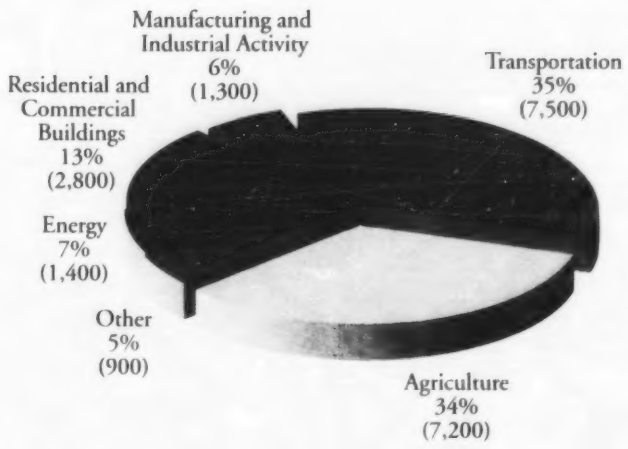

Manufacturing and Industrial Activity 6% (1,300)
Transportation 35% (7,500)
Residential and Commercial Buildings 13% (2,800)
Energy 7% (1,400)
Other 5% (900)
Agriculture 34% (7,200)
Total: 21,100 kilotonnes of CO_2 equivalent

Figure 9. Manitoba emissions by sector in 1998.
Source: Environment Canada

Manitoba's Economic Sectors

Agriculture

Land use for agriculture in 1996 totaled over 7.7 million hectares in Manitoba, or over 50 per cent of total lands with agricultural potential. In 1998, 4.8 million hectares were seeded to crops; 0.18 million hectares had been summer-fallowed; and two million hectares were pasture lands.[8]

Although southern Manitoba has the climate and soil to grow a wide range of crops, the traditional grain crops of wheat and barley occupied the largest area. Manitoba produces other crops, including canola, oats, rye, flaxseed, sunflower and mixed grains. Manitoba is not only an important source of grains and oilseeds, but is also a major area for the production of specialty crops in Canada. The production of specialty crops like buckwheat, canary seed, dry beans, dry peas and lentils has increased over the past years due to the larger areas being devoted to these crops and higher yields. In addition, Manitoba's livestock and vegetable (particularly potato) industries represent important players in the agriculture sectors.

Agriculture can play an important role in Manitoba's response to the climate change challenge by adopting sustainable agricultural practices that would work to sequester and reduce GHG emissions. Examples include increased zero tillage, reduced summer fallow, improved grazing strategies, and conversion of croplands to wetlands and wildlife habitats. These procedures store and absorb carbon, instead of releasing it into the atmosphere where it would contribute to climate change. Other areas with promise include crop

8 Manitoba Agriculture, http://www.gov.mb.ca/agriculture

A Manitoba fall harvest. Climate issues could spell major changes for agriculture.
Photo courtesy Manitoba Agriculture

nutrient management, livestock nutrient management, manure management and the development of fuels from the processing of grains, garbage and trees. However, keep in mind that the sheer number of farmers and the complexity of the systems make the monitoring and verification of individual actions very difficult and expensive. In general, the Canadian agriculture industry, including Manitoba's, operates in global markets with a constrained capacity to pass additional costs on to consumers.

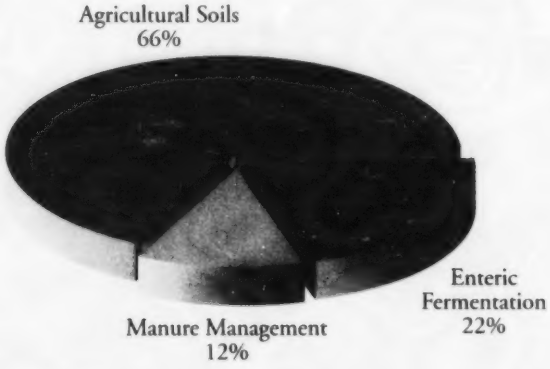


Figure 10. Emissions from the agricultural sector.

The research directed toward GHG reduction in agriculture is still at a preliminary stage. More knowledge about the effects of current technologies and their role in today's farming systems is needed. Research into these areas will result in the development of more sustainable technologies in the future.

Forestry

Manitoba forests make up about 26.3 million hectares of the province's 54.8 million hectare land base.[9] There are two main types of forests in Manitoba: the Northern Coniferous and the Broadleaf/Mixedwood forests. The Northern Coniferous, or boreal forest, is Manitoba's largest forest zone. It covers a broad area across the north-central and central part of the province, extending across the eastern border into Ontario. This forest contains black spruce in the lowland bogs and fens; and jack pine, poplar and white spruce on the uplands.

Manitoba's boreal forests support the majority of the province's forest industry, providing resources for craft paper, lumber and newsprint. First Nations communities are located throughout the boreal forest and the area is an important tourist destination. The Broadleaf/Mixedwood forest, or Aspen Parkland, dominates the south-central portion of the province.

In 1997, forestry contributed $418 million in gross domestic product (GDP) to Manitoba's economy. Approximately 9,000 people are employed directly by the forest

9 Manitoba Conservation, http://www.gov.mb.ca/natres/forestry/

industry. Of Manitoba's forested lands, about 94 per cent are owned by the province. The federal government owns one per cent and the remaining five per cent is privately owned. The annual allowable harvest limit for timber on Manitoba's Open Crown Lands is just under 9.7 million cubic metres, while the actual harvest in 1996 was 2.1 million cubic metres on 15,342 hectares of land. While the forestry industry has been export-oriented, the industry is becoming more globalized. Yields from equatorial regions of the world are considerably higher than that of Manitoba, and with new technologies, it is easier to substitute Manitoba's softwood with this hardwood from the south.

The forestry sector in Manitoba has the opportunity to reduce its greenhouse gas emissions by improving its energy efficiencies as well as activities that capture and store more carbon through photosynthesis of CO_2 from the atmosphere into the wood of the tree. By reducing its dependence on fossil fuels and switching to other power sources in the processing of the products, the forestry sector can reduce some of its greenhouse emissions. Through efforts in the ethanol industry, the forestry sector might have the opportunity to produce material for the development of efficient ethanol production using hybrid poplars and other fast growing trees. The other potential for the forestry sector to reduce greenhouse gas emissions is through the photosynthesis of carbon dioxide from the atmosphere into the wood of the trees.

Forests cover about 26.3 million hectares of the province.
Photo by Elaine Gauer, Manitoba Agriculture

There is a need to conduct more research and focus on social, economic and policy impacts. There is potential for an increase in Aspen Parkland forests, which could supply the industry with other materials. As with most sectors, forestry has the ability to develop new technologies to reduce greenhouse gas emissions and also adapt to climate change through the use of new tree varieties that enhance growth potential as well as have lower water requirements.

Aspen Parkland. About 9,000 Manitobans are employed directly by the forestry industry.
Photo by Elaine Gauer, Manitoba Agriculture

There are a number of adaptation options for the forestry sector to address. Emphasis on diversity-resilience, such as mixed wood management, is seen as a critical step forward. Increased levels of management for seedling survival and firebreaks to prevent fire spread are also adaptive strategies. The key opportunity for the forestry sector is to start pilot programs on forest management with a focus on adapting to climate change and pursuing activities that would work to increase forestry's sequestration capacity.

Energy

In 1997, Manitoba's energy requirements cost consumers $2.8 billion. Manitoba produced about half as much energy as it consumed in 1997. The rest was purchased from outside the province, mainly in the

form of natural gas, which cost Manitobans $2 billion that year. Hydroelectricity supplies close to 25 per cent of the energy or 99 per cent of the electricity consumed in Manitoba. In fact, Manitoba currently produces a surplus of hydro-sourced energy and exports about half of its electricity. Producing and distributing hydroelectricity from existing infrastructure does not result in significant levels of greenhouse gas emissions and thus could be considered a "climate-friendly" power source. Other forms of renewable energy in Manitoba include wood, ethanol and electricity from the wind and sun. To date, Manitoba has not placed a great deal of emphasis on alternate forms of renewable energy, because of the relatively low cost of hydroelectricity production.

A future carbon-constrained world represents a real economic opportunity for Manitoba's hydro industry. As fossil-fuel burning power plants in other parts of North America are phased out, the demand for hydroelectricity is expected to rise. Moreover, if an emissions trading system is introduced in North America, hydro producers might be able to beat their emissions target and sell excess emissions allowances to utilities who cannot meet their targets.

An older hydroelectric power generating station. New technologies will reduce the amount of water needed to operate these stations.
Photo courtesy Manitoba Hydro

The Limestone Generating Station on the Nelson River. Renewable energy sources supply close to 25 per cent of energy consumed in Manitoba.
Photo courtesy Manitoba Hydro.

In addition, Manitoba has a number of options to reduce its greenhouse gas emissions from its use of energy, as well as build up its expertise on renewable energy options. Green technologies, such as mini-hydro turbines that minimize environmental disruptions, photovoltaic cells (solar cells) and windmills, can all contribute to reducing greenhouse gas emissions. By including potential greenhouse gas emissions into the approval process of projects, Manitoba could reduce new GHGs before they are emitted.

Transportation

Transportation is an integral part of Manitoba's economy. Because of Manitoba's large area and sparsely distributed population, the transportation system is very extensive. The vast majority of passenger transportation is based on automobiles, with considerably fewer people using public transit, cycling and walking in urban centres. Longer passenger travel also includes intercity buses, trains and air, with some minor uses of marine. Freight transportation is supported by trucks, railways, air, marine and pipelines. Trucking is the most significant form of moving freight within the province and between the province and other locations. Manitoba's trucking industry consists of 33 major carriers, a third of which are based in Winnipeg.[10]

10 Manitoba Industry, Trade and Tourism, http://www.gov.mb.ca/itt/trade/invest/bus_facts/trans_infractructure/

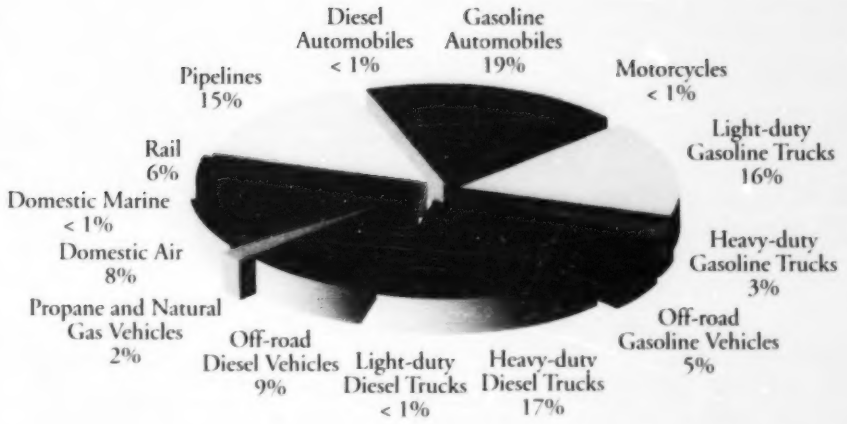


Figure 11. Emissions from the transportation sector.

A number of key challenges face transportation in Manitoba. On the passenger side, nearly 80 per cent of Manitobans rely on automobiles to get to work.[11] Urban bus transport has been decreasing, even though the numbers of buses and routes are increasing. Timewise, it is still more efficient for most people travelling from the suburbs to offices downtown to use their own vehicles instead of relying on public transit. On the freight side, the demand for transportation is based on the products moving either in or out of the province, including movements within the province. This derived demand is not something the transport system can control, which limits some of its options to adapt. Also, many industries operate on a "just in time" basis which puts more emphasis on rapid delivery on products, again limiting some options for reductions in greenhouse gas emissions.

Travel to northern communities is very dependent on the weather producing solid winter roads that support the weight of trucks hauling materials to the remote communities. When trucks cannot make the journey north, people must rely on airplanes, thereby increasing the cost of goods in these communities. Marine transportation could benefit from climate change due to the warmer conditions that will extend the season for Manitoba's only seaport at Churchill. Movement of grain from the port of Churchill has increased dramatically in 2000, almost doubling 1999 movements due to an increasing ice-free season on the Hudson Bay.

Transportation represents one of the most significant sources of greenhouse gas emissions in Manitoba, contributing approximately one third. This places increased pressure on the transportation sector in Manitoba to develop systems to reduce emissions.

A number of options have been suggested to reduce transportation-related greenhouse gases, with the majority of them focusing on urban movement. The transit system needs to improve speed, information about routes and location of vehicles. Most people do not enjoy waiting for the bus in the winter months. Telecommuting—working from home and communicating with the main office electronically—has also been suggested as a way to reduce emissions.

The trucking industry also has options to reduce its greenhouse gases, including training of operators to be more efficient, the use of longer trucks and load matching. Load matching ensures the truck travels with a full load. Empty trucks use similar amounts of fuel as loaded trucks. Opportunities for inter-modal shifts in transporting freight—from trucking to rail, for example—also need to be explored.

Manitoba is also home to many new technology industries in the transportation sector. Whether in the field of alternative fuels or developing alternatives to the internal combustion engine, these industries provide another unique opportunity for Manitoba to use climate change to its economic advantage. For these industries to succeed, the development of a supportive infrastructure will be critical, inside Manitoba and throughout North America.

11 IISD, *Sustainable Transportation in the Prairies*, unpublished research report, 1997.

A Manitoba Success Story – Kraus Group Inc.

Kraus Group Inc. is a Manitoba-based company that designs and manufactures refueling equipment for petroleum and alternative fuels for the transportation sector. The company constructs fuel-dispensing outlets in countries all around the world. It has found that demand for clean alternative transportation fuels—like propane, natural gas and compressed hydrogen—continues to grow, especially as countries work to lower urban air pollution and reduce their greenhouse gas emissions.

The Kraus Group has translated that demand into recent successes, like building the two largest compressed natural gas refueling outlets on the planet in Mexico City. Each outlet has the capacity to service 1,600 vehicles a day. Currently, the outlets are fuelling a fleet of police cars and natural gas converted buses. Future plans in Mexico City call for the construction of another 100 outlets over five years. The Kraus Group is the principal partner in this project and its participation will help Mexico City address its staggering air pollution problem.

http://www.iisd.org/business/kraus.htm

Hydrogen dispenser. Manitoba is well-positioned to be on the leading edge of emerging energy technologies.
Photo courtesy Kraus Group Inc.

Manufacturing and Industrial Processes

The manufacturing sector in Manitoba includes industries such as aerospace, agribusiness, apparel and textiles, commercial printing, component manufacturing, environmental industries, information and communications, and transport equipment—a diversity representing approximately 11 per cent of Manitoba's GDP in 1998. The industrial processing sector is quite small in Manitoba with some non-metallic mineral production and ammonia and acid production, among others activities.

Although it is not predicted that manufacturing in Manitoba will be directly impacted by climate change, one indirect effect could be the availability of inputs. Industries relying on natural resources, like agriculture and forestry, might experience problems due to the potential changing nature of those industries. Water is another example of an input in short supply as many sectors compete for a smaller amount in the summer months.

The manufacturing sector is only responsible for 5.5 per cent of Manitoba's emissions primarily because of the types of production used in the province. Opportunities for reduction might come from improving energy use within a production process.

Residential and Commercial Buildings

Buildings in Manitoba are also sources of greenhouse gas emissions, representing 15 per cent of the provincial total. The emissions are shared equally between residential and commercial buildings. The majority of the buildings are heated with natural gas, followed by electricity and then wood.

The potentially increasing winter temperatures would reduce the amount of energy required to heat the buildings, while the warmer summers could increase cooling costs. The net effect should be a decrease in greenhouse gas emissions due to the reduction in natural gas in the winter and increases in electricity for air conditioning in the summer.

Opportunities to reduce emissions, and potentially operating costs, could come from increasing insulation efficiencies as well as building designs that take advantage of passive heating and cooling. Programs also exist to improve building efficiencies with Manitoba hydro and other institutions.

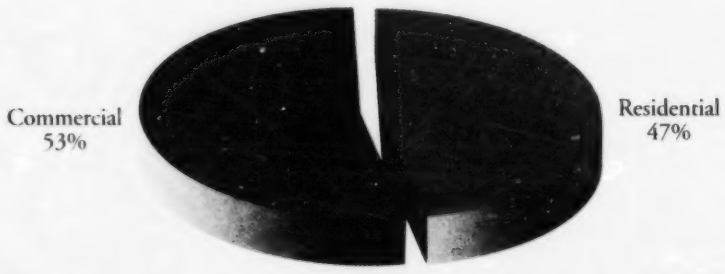


Figure 12. Emissions from buildings.

Individuals and Communities

Individual Manitobans can make a difference. Each of us has a number of options for reducing GHG emissions. Many of these, such as investing in better home insulation or taking public transportation, also save money in the long run. Natural Resources Canada has developed a web site at http://oee.nrcan.gc.ca/ that gives suggestions on what households can do to reduce their GHG emissions. These include vehicle purchases and maintenance, home insulation, home appliances and more. The Pembina Institute's climate change solutions web site at http://climatechangesolutions.com offers suggestions, tips and success stories for how individuals, families and even schools (as well as municipalities and businesses) can reduce their emissions and save money. The Government of Canada's climate change web site at http://www.climatechange.gc.ca has an entire section highlighting actions individuals can take that make a difference to the global climate.

Municipalities can influence, directly and indirectly, greenhouse gas emissions from landfills, transportation, heating buildings, and other sources. Effective greenhouse gas emissions management by communities and municipalities calls for careful short-term and long-term planning. In the short run they can monitor emissions, look at reducing barriers to action, and work to increase efficiency. Water conservation and improved treatment, along with beneficial landscaping, are good short-term activities to adapt to climate change.

-1/2

M121

IMPORTANT NOTE CONCERNING THE FOLLOWING PAGES

THE PAGES WHICH FOLLOW HAVE BEEN FILMED TWICE IN ORDER TO OBTAIN THE BEST REPRODUCTIVE QUALITY

USERS SHOULD CONSULT ALL THE PAGES REPRODUCED ON THE FICHE IN ORDER TO OBTAIN A COMPLETE READING OF THE TEXT.

REMARQUE IMPORTANTE CONCERNANT LES PAGES QUI SUIVENT

LES PAGES SUIVANTES ONT ÉTÉ REPRODUITES EN DOUBLE AFIN D'AMÉLIORER LA QUALITÉ DE REPRODUCTION

LES UTILISATEURS DOIVENT CONSULTER TOUTES LES PAGES REPRODUITES SUR LA FICHE AFIN D'OBTENIR LA LECTURE DU TEXTE INTÉGRAL

micromedia
a division of IHS Canada

20 Victoria Street
Toronto, Ontario M5C 2N8
Tel.: (416) 362-5211
Toll Free: 1-800-387-2689
Fax: (416) 362-6161
Email: info@micromedia.on.ca

You Can Make a Difference By ...

- **Leaving the car at home and walking or biking for short trips. For longer trips, take the bus. One busload of passengers takes 40 vehicles off the road during rush hour, saves 70,000 litres of fuel and avoids over 175 tonnes of emissions a year.**
- **Avoiding idling your vehicle—ten seconds of idling uses more fuel than restarting your engine.**
- **Turning off lights, appliances, televisions and computer when they're not needed.**
- **Sealing all leaks around doors, windows and cracks where heat escapes from your home (and save up to 20 per cent on your heating bill!)**
- **Insulating when you renovate. Over the years, a small up-front cost can pay for itself several times over in energy savings.**
- **Checking the EnerGuide label. When buying new household appliances, room air conditioner or vehicle, the EnerGuide label can help you select the most energy-efficient model that meets your needs.**
- **Installing a programmable thermostat to automatically change the temperature of your house at different times of the day. For every degree you lower the heating level, you'll save two per cent on your heating bill.**
- **Cleaning your furnace filter regularly and keeping your furnace properly tuned. A well-maintained unit uses 10-15 per cent less energy.**
- **Reducing consumption of paper and other resource-intensive products, and reusing and recycling where possible.**
- **Selecting food and products that are grown or manufactured locally rather than trucked or flown from elsewhere.**

Tips courtesy of the Government of Canada's climate change web site at http://www.climatechange.gc.ca

In the longer term, municipalities can have a real impact on greenhouse gas emissions through ingenious design of transportation systems, forward-thinking urban planning to minimize urban sprawl, and changes to building codes to improve efficiency. Communities can also help families and industries adapt and participate in strategies to build up economic resilience. This would require improved access to the best information possible.

Some communities across Canada have experimented with projects to reduce emissions and save costs. For example, Winnipeg has tested capturing methane from its wastewater treatment.

You Can Make a Difference By ...

- **Leaving the car at home and walking or biking for short trips. For longer trips, take the bus. One busload of passengers takes 40 vehicles off the road during rush hour, saves 70,000 litres of fuel and avoids over 175 tonnes of emissions a year.**
- **Avoiding idling your vehicle—ten seconds of idling uses more fuel than restarting your engine.**
- **Turning off lights, appliances, televisions and computer when they're not needed.**
- **Sealing all leaks around doors, windows and cracks where heat escapes from your home (and save up to 20 per cent on your heating bill!)**
- **Insulating when you renovate. Over the years, a small up-front cost can pay for itself several times over in energy savings.**
- **Checking the EnerGuide label. When buying new household appliances, room air conditioner or vehicle, the EnerGuide label can help you select the most energy-efficient model that meets your needs.**
- **Installing a programmable thermostat to automatically change the temperature of your house at different times of the day. For every degree you lower the heating level, you'll save two per cent on your heating bill.**
- **Cleaning your furnace filter regularly and keeping your furnace properly tuned. A well-maintained unit uses 10-15 per cent less energy.**
- **Reducing consumption of paper and other resource-intensive products, and reusing and recycling where possible.**
- **Selecting food and products that are grown or manufactured locally rather than trucked or flown from elsewhere.**

Tips courtesy of the Government of Canada's climate change web site at http://www.climatechange.gc.ca

In the longer term, municipalities can have a real impact on greenhouse gas emissions through ingenious design of transportation systems, forward-thinking urban planning to minimize urban sprawl, and changes to building codes to improve efficiency. Communities can also help families and industries adapt and participate in strategies to build up economic resilience. This would require improved access to the best information possible.

Some communities across Canada have experimented with projects to reduce emissions and save costs. For example, Winnipeg has tested capturing methane from its wastewater treatment.

The Path Ahead

Climate change is a reality. Manitobans, like all citizens of the world, need to recognize this, find ways to reduce emissions and seek ways to adapt to its impacts. Changing behaviours and learning to adapt require hard work and innovation. Some sectors have already undertaken activities to take advantage of opportunities and protect themselves, but more work is still required. Reducing GHG emissions and implementing appropriate adaptation strategies requires action from government, industry and individuals.

Manitoba could consider developing an action plan, with the leadership of the provincial government, that outlines no-regrets activities, seeks a position for the province as a world leader in renewable resources and environmental technologies, promotes adaptation strategies, invests in climate science and encourages individual Manitobans to reduce their emissions.

The government has a responsibility to Manitobans to ensure they are receiving the most up-to-date information to allow for better decision-making and to supply research in areas that need it. For example, a better understanding of the links between climate change, land use, water use and energy use is required. This is particularly important in policy design, as changes in one sector might have significant effects on others. Methods are required that can estimate some of these effects. Some research and development resources provided by the government can create the potential for industry to benefit from adopting better technologies. An informed industry will also recognize that, given the importance of the environment in international markets, and the potential to trade emissions reductions, developing an industry with low GHG emissions might be good business.

Industries also have a role in reducing GHG emissions and adapting to climate change. Industries can start making significant efforts in reducing GHG emissions by adopting new technologies when aging equipment is replaced. This reduction can also come from analyzing production processes to identify efficiencies that will not only reduce emissions, but produce economic benefits as well. The International Institute for Sustainable Development's business web site, http://www.iisd.org/business/, offers examples of methods for analyzing production and seeking efficiencies. The site also lists other resources.

Although climate models are becoming more accurate and reliable, they tend to be better at providing global predictions than local ones. Moreover, they do not attempt to address other aspects of climate change, such as effects on the economy and society. More work is needed to develop comprehensive models that incorporate all three systems (social, economic and physical) to address all aspects of adaptation.

The impacts of climate change on Manitobans could be significant if we do not develop our own robust strategies to address these potential changes. But the changes start at home. Each Manitoban has an obligation to reduce their own emissions of greenhouse gases not only for themselves but also their children and their children's children.

Climate Change Internet Resources

www.unfccc.int – United Nations Framework Convention on Climate Change. This site includes the complete text of the Kyoto Protocol plus statistics and background on climate change.

www.nccp.ca – The National Climate Change Process. This site includes information about Canada's actions on climate change with links to a variety of other web sites.

www.ipcc.ch – Intergovernmental Panel on Climate Change. This site includes the publications of the IPCC as well as links to other climate web sites.

www.climatechange.gc.ca – Government of Canada Climate Change. This site has links to federal departments' material on climate change, describing adaptations and impacts.

www.ec.gov.ca/climate/ccs/ – Canada Country Study. This site highlights the impacts of climate change throughout Canada.

www.iisd.org/climatechange.htm – International Institute for Sustainable Development. IISD's web site on climate change highlights regional, national and international material on climate change.

www.weathervane.rff.org – Weathervane. This web site is a digital forum on global climate policy published by Resources for the Future.

www.taiga.net/nce – The Northern Climate Exchange. This web site features climate information on northern regions.

www.pewclimate.org – The Pew Foundation. The Pew Foundation's climate change web site focuses on credible information and innovative solutions.

www.pembina.org/climate – The Pembina Institute. This climate change web site highlights solutions.

www.vcr-mvr.ca – The Voluntary Challenge Registry. This web site records some of the public action taken by Canadian organizations to reduce their greenhouse gas emissions.